FINNISH ROAD ADMINISTRATION

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Key words: tyres, heavy vehicles

ABSTRACT

The purpose of the study was to compile information about tyre pressures and tread depths as well as about tyre and brake temperatures on trucks and trailers. This material is needed, for example, in assessing the safety of heavy transport and the strain on the road network caused by it.

A total of 202 trucks and 3,256 tyres were examined. All measurements were done in the Greater Helsinki Area and its environs in May 2000.

In general, the tyres on trucks and trailers were in a relatively good condition. Nevertheless, 5.1 per cent of the trucks with a full trailer and 11.1 per cent of the trailers had a minimum of three worn-out tyres. On these vehicles, tyre quality deteriorated towards the rear: on trucks, the front tyres were in a good condition, but some substandard tyres were found on the front axles of the trailers, and the worst tyres were fitted on the rearmost axle, so that on axle four, almost all tyres were in a bad condition.

Tyre temperatures on average seemed to rise with brake temperatures up until 40°C. On trailers, the tyres and brakes warmed up less than on trucks. Tyre and brake warming has a clear and natural connection with the load. On fully loaded trucks without trailer or with a semitrailer, the brakes were on average 20°C warmer than on empty trucks. As regards truck and trailer combinations, the difference was a little less than 20°C on trailers and 15-20°C on trucks. Of all the measured vehicles, six had a temperature difference exceeding 40°C between the left and right front brake.

In about 80 per cent of the tyres, tyre pressures ranged between 7.0 and 9.5 bar, depending the width of the tyre and whether it was a single or dual tyre. The rest of the tyres were considerably underinflated or somewhat overinflated. On single wheels, the tyre pressures were generally higher than on dual wheels, and clearly underinflated tyres were relatively more common on dual wheels. On dual wheels, the tyre pressure was on average 7.9 bar on both tyres of a dual set; in 42 per cent of the cases, the pressure difference between the inner and outer tyre was less than 0.5 bar and 92 per cent had a difference not exceeding 2 bar. Random interviews indicated that most drivers performed only visual checks on tyre pressures.

FOREWORD

This study used field measurements to compile information about tyre air pressures and tread depth as well as about tyre and brake temperatures on trucks and trailers in traffic in Finland. The measurements were done in May 2000. The study was commissioned by the Vehicle Administration, Finland, and the Finnish National Road Administration (Finnra), and these agencies were represented by Ove Knekt and Pekka Räty, respectively; they also acted as the team supervising the study. The study is associated with the Vehicle Administration's technical supervision and Finnra's Road Structures Research Programme.

The study was implemented by the Automotive Engineering Department of the Helsinki Polytechnic, Test Center Tiililä Oy (TCT) and nine 3rd and 4th-year automotive engineer students. Turo Tiililä of the TCT supervised data compilation and carried out preliminary categorization of the material. The Laboratory of Automotive Engineering at the Helsinki University of Technology made the report based on this material. The report was written by Research Assistant Lassi Partanen and Laboratory Manager Panu Sainio, M.Sc. (Eng.). Portions of the report were quoted from the measurement report made by the TCT.

The report contains examples of relevant literature at the end of each theoretical section. Some of these books are manual-type general textbooks, while others are more theoretically oriented. In Finland, these books are available at the library of the Laboratory of Automotive Engineering at the Helsinki University of Technology, Espoo. The research material is available at the Vehicle Administration and the Finnish Road Administration's Traffic and Road Research unit, both of which are located in Helsinki.

March 2001

Finnish Road Administration
Traffic and Road Research

Sisältö

1 INTRODUCTION

Along with axle masses, tyre pressures have an impact on the strain caused by traffic on the road and on the entire network. In this study, a sample of tyre pressures comprising 202 trucks and 3,256 tyres was collected. The aim was to utilize this material in, e.g. modelling the service life of road structures. The sample was compiled during May 2000 in the Greater Helsinki Area and its environs at 12 commercial and industrial loading and unloading areas and heavy-traffic rest areas. In order for it to be representative of the vehicle stock and type of transport currently in use, the sample was divided into 12 categories according to vehicle type and purpose of use, with the minimum measurements defined for each category.

An effort was made to measure tyre pressures on each tyre of the vehicles selected for the study. Other information about the tyres and vehicles was compiled as well: tyre and brake temperatures; tread depth and the general condition of the tyre and rim; tyre size, brand and status (original / retreaded); the position of the axle on the vehicle and the distribution of the axles as combination or single axles; the type of spring suspension and tyre combinations in each axle, and information as to whether the axle was up or down. In addition, the registration number, nationality, type, load/capacity ratio and general condition of the vehicle were recorded.

This information served not only modelling of road structure durability but also traffic safety work. Of the fatal accidents examined by the Finnish Road Accident Investigation Teams, in 16 per cent of accidents (i.e. one out of six), tyres were a contributory risk factor. During the winter period between November and April, in one out of four cases the tyres of the vehicle causing the accident played a contributory role. In 1991-1998, the Road Accident Investigation Teams examined 2,209 fatal accidents involving motor vehicles. In 357 cases, defective tyres were reported as a risk factor.

Two separate measurement teams were formed, both of which had at least four measurers. Prior to the actual measurements, a training session was held in order to agree on measurement methods, vehicles to be measured and contact persons. The latter were in daily contact with each other. A summary was made each evening with regard to the trucks measured, and decisions were made on the measurements to be done the following day. This made it possible to avoid overlap between measurement sites and vehicles, and to update information about the fact that the targeted amount of, e.g. semitrailers had been measured, making further measurements of this type unnecessary.

Before measurement started, an exercise was organized by using a truck loaded with soil. Data on this vehicle were collected in the same way as was supposed to be done in the field. This made it possible to ensure that both teams used the same methods and assessment criteria, enabling mutually comparable measurement results.

2 MEASUREMENT TOOLS

Both teams were issued with two air pressure gauges and one spare gauge. The readings of the air pressure gauges (Wika 213.53.100 0-10 bar) were checked at 1-bar intervals before and after measurement by using a reference gauge, calibrated at an accredited calibration laboratory. In addition, the measurement teams made checked the gauges daily to ensure that they gave the same readings. Suitable hoses were manufactured, and extensions were acquired for measuring pressures on the inner dual tyres.

It was known in advance that, while it is possible to install extensions on the inner tyres in order to facilitate pressure measurement, such extensions are not common. During measurement, it turned out that only less than half of the valves had extensions. Especially in soil and timber transport, extensions do not last for long because the vehicles are used on forest truck roads and building sites. The absence of a valve extension makes tyre pressure measurement difficult or, in some cases, impossible.

To measure temperatures on tyre tread, easy-to-use infrared measuring devices (Raytek Raynger ST) were acquired. The device emits a laser beam that can be directed at the measurement point. Both teams had two such devices at their disposal. The readouts of the devices were checked at many temperatures before and after measurement. As a reference was used a Metex P7178 (k type) thermometer, which had been calibrated at an accredited calibration laboratory. In practice, the readouts of the infrared devices deviated from the reference tool by ± 2°C. In addition, each measurement team made daily checks to ensure that the devices used by the team gave the same readouts. The measurement report does not specify the type of surface used in checking the infrared devices.

Both teams were supplied with two devices used in measuring tread depth. Their precision was tested by a block gauge. The precision of the instruments was approximately 0.5 mm.

A compressor and a generator set complete with transport equipment were rented for each team for inflating tyres if necessary. The teams were also equipped with a jack and tools for replacing tyres. This was done for possible tyre changes in the field, if a valve broke during measurement. However, this equipment was not needed.

The valve tools, on the other hand, proved to be necessary. The valve sealing caps were often so tight that they were impossible to unscrew by hand. On dual tyres, the outer cap was removed with pliers, while the inner valve was opened by using a special tool made for this purpose: this was simply a long extension arm, which had a conical cavity fitting the cap. The extension arm was inserted through a hole in the outer rim, and the conical cavity was pressed tightly on top of the cap, which was then easy to open with an ordinary tool.

3 FIELD MEASUREMENTS

The aim was to compile information about 200 trucks and their trailers. The vehicles had been grouped into four categories based on their load and into three categories based on the possible trailer.

Table 1. Trucks to be measured by load and type of trailer. Target numbers / actual numbers in brackets.

Load	Truck without trailer	Truck with semitrailer	Truck with trailer
Raw material (timber, metal)	10 (9)	0 (2)	30 (21)
Soil (gravel, construction material)	30 (28)	0 (0)	10 (0)
Liquid fuel	0 (0)	0 (0)	20 (21)
Other (trade, industry)	20 (25)	40 (39)	40 (47)

No regional requirements for measurements were set, and therefore all measurements were conducted in the Greater Helsinki Area and its environs. The measurement sites were mainly selected depending on what type of vehicle remained unmeasured and on where they were most likely to be found. During the first days, the number of vehicles measured increased rapidly, since almost all trucks qualified for some category. After a few days, some quotas had been met, and the pace of measurement slowed considerably. For example, during one particular day, one of the teams was able to measure only five vehicles in six hours. Because one truck-trailer combination took 20 minutes to measure, this means that the team spent almost five hours waiting that day.

Measurement sites had been only tentatively determined beforehand, so that it was possible to choose the actual site based on the previous day's results. The measurements were carried out on the following locations: Maaliikennekeskus (an important goods transport terminal in Helsinki); the Ämmässuo rest areas on Main Road 1; the Karhunkorpi rest area on Main Road 3; service stations Shell Pasila, Shell Vanhakartano and Esso Kitfall in Lohja; Transpoint depot in Pasila; Sompasaari terminal; service station Ysi5 and Neste Refinery in Kilpilahti; Loppi; and Hakkila, Vantaa.

On site, the service station or cafeteria owner's permission to conduct measurement was asked, and arrangements were made to serve coffee to the drivers. The owners of the service stations and cafeterias took a very positive stance on the measurements. Only one cafeteria was about to forbid measurement, but, having been informed about the nature of the operation, the proprietors changed their minds. When a suitable vehicle was found, the driver was asked for permission to conduct measurement. Also the drivers viewed the operation along positive lines, although at times it seemed that they were at first afraid of a police road check.

The following information about the vehicles was recorded: the make and model; registration number; nationality; vehicle type; load (raw materials, soil, fuel or other); load/capacity ratio (empty, half-full, full); parking time prior to measurement; and general condition on a scale of 0-3. Information about the load and load/capacity ratio was provided by the driver. Some trailers had no model specifications, and not even the driver could always provide this information.

On each axle, the following information was recorded: single axle or bogie; drive or ordinary axle; up or down position; type of suspension; and brake temperature. Brake type (disc or drum) was not recorded.

Concerning the tyres, the following information was recorded: brand; size; original or retreaded tyre; condition of the sidewalls on a scale of 0-3; tyre pressure, tread depth and temperature. Tread depth was measured on the most worn-out spot. Sidewalls were categorized based on the following criteria:

- 3: brand-new tyre
- 2: flawless sidewalls
- 1: rubber had cracked from ageing or had small fissures.
- 0: sidewalls had large fissures, bulges, etc.

Tyre pressure measurement was not always successful. There were problems with measuring the inner pairs of dual tyres, in particular: the valve was not found, or the valve was obstructed by the outer rim. In some cases, the valve or its extension appeared to be in such a bad condition that the measurer considered it better to refrain from opening it. The pre-set goal was that pressures would be measured at least in 75 per cent of the inner pairs of dual tyres. However, this goal was achieved better than expected, since measurement was successful in 93 per cent of the cases (1,036 out of 1,110). All in all, the material comprised information about 3,256 tyres.

An effort was made not to put any drivers unreasonably behind schedule, so measurements were done as quickly as possible. A truck and trailer combination took 20 minutes, a semitrailer truck 15 minutes and a truck without a trailer took 10 minutes to measure. The measurement team had intended to replenish underinflated tyres, but drivers were sometimes too impatient to wait for this – an observation that is alarming as such.

Each vehicle was measured by four persons. On each side of the vehicle, there were two pairs, comprising the measurer and recorder. First, both pairs measured brake temperatures, whereupon other data were measured and written down. The information was compiled on field forms (see Appendix 2).

In general, the vehicles and tyres were in a good condition. During the course of the study, no tyres had to be replaced. The valves caused some close calls: when the pressure had been measured, the valve could start leaking, probably due to a stone fragment or dirt that managed to slip under the valve pin, preventing the valve from closing properly. The obstacle was removed by pressing the pin hard for a few times. This was typical of trucks hauling soil or timber because off-road situations often cause dirt to accumulate on the wheels and valves. Of the some 3,200 tyres inspected, only a few valve pins were replaced because of breaking. About 150 new valve caps were added or replaced. It is somewhat alarming that so many caps were missing.

4 ATTITUDES TOWARDS TYRES AMONG COMPANIES AND DRIVERS

This study showed that trucks and trailers as well as their tyres were in a relatively good condition; this is not surprising, given the effective supervision implemented by the Finnish vehicle inspection authorities and the police. Nonetheless, there were major differences in vehicles and tyres between various transport companies. Some firms accept retreading only once and require that only new tyres are used on drive axles. On the other hand, many small firms replace tyres one at a time, depending on which tyre is worn out, but an effort is made to fit dual wheels and drive axles with tyres whose tread is equal. Thus, vehicles may have tyres of different brand on each axle, a situation that is of course perfectly legal. However, different tyre brands perform differently, a fact that may be a road safety risk.

According to random interviews, drivers did not normally check tyre pressures. After a tyre was replaced, nobody touched it until it was time to replace it again; only a visual check was done from time to time. If the pressure difference in the front tyres exceeds 1 bar, the driver will notice this as steer problems, in which case the front tyres will be inflated.

5 ANALYSES

5.1 Tread depth

5.1.1 Theoretical considerations

A tyre may start aquaplaning at a surprisingly low speeds, if the tread depth is insufficient; the water layer on the road need not to be thicker than a couple of millimetres. When a tyre is aquaplaning, a water cushion forms between it and the road surface, lifting the tyre off the road. This phenomenon is comparable to an oil layer reducing friction in a ball bearing. Such a water cushion cannot occur when the surface is rough enough or the tread pattern is able to channel the water away from the tyre. The depth of this pattern has a major role in this respect. If the tread depth is not adequate, water does not have enough time to disappear from under the tyre during the approximate 0.01 seconds a particular rubber section spends in touch with the road.

In practice, it is very rare that a heavy vehicle would aquaplane. However, the risk of aquaplaning does exist when the tyres are worn out or when the truck has no load. Another relatively high risk associated with worn-out tyres occurs when the brakes are locked. Then, the tyre may wear out rapidly and the fabric may become exposed, causing the tyre to blow up. In addition, a tyre with a worn-out tread heats up more than an ordinary tyre, which can dissipate heat through the grooves in the tread pattern. On snow or off the road, the depth of tread plays a crucial role in terms of the attainable friction level.

For more information:
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Juurikkala, Jussi. *Autokirja.* 1988.
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VTI notat 77.1997. *Tunga fordons däckanvändning – trafiksäkerhet, etapp 2.*
Nordström, Olle. *HCVs on Ice – Friction Properties of New and Worn Treads.* Reprint from Tyre Technology International 1999. P. 75-82. VTI särtryk 324. 1999.

5.1.2 Measurement results

During measurement, tread depth was separately recorded on each tyre. In order to facilitate data processing, summary tables were compiled (see Appendix 3). Based on the summary tables, graphs were made to illustrate the distribution of tread depths (see Chapter 5.1.3). The graphs were grouped on the basis of tyre width as single tyres (width over or under 350 mm) and dual tyres. The position of the tyres or axle type were not taken into account in the graphs.

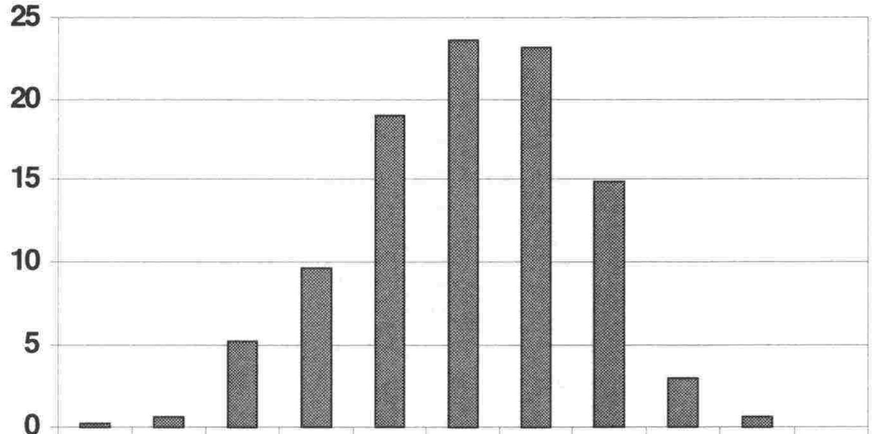
According to Finnish regulations, the depth of tread must be a minimum of 1.6 mm. In the study material, the precision was one millimetre, so it is not possible to deduce indisputably which tyres were illegal. In practice, a tyre is rapidly becoming illegal, if its tread depth is about 2 mm. Thus, the analysis considered a tyre worn out if its tread depth was 2 mm or less.

The analysis commenced by retrieving data on all vehicles that had at least one worn-out tyre. In general, the tyres were in a good condition; for example, trucks without a trailer had no worn-out tyres. In semitrailers, worn-out tyres occurred in 7 cases involving the trailer and in 3 cases involving the tractor, out of a total of 41. The majority of worn-out tyres were found on actual trailers and their trucks: 40 out of 102 trailers and 27 out of 99 trucks. A total of 104 out of 3,256 tyres had tread depths less than 2 mm.

A more accurate analysis was conducted on vehicles that had at least three worn-out tyres. These occurred on trailers proper and the tractors/trucks hauling them. Of the trucks, 5.1 per cent (5) had at least three worn-out tyres. On these trucks, tyre quality deteriorated towards the rear of the vehicle, whereas the front axle was in a good condition. On actual trailers, 11.1 per cent (11) had a minimum of three worn-out tyres. It seemed that also on trailers, the worst tyres were fitted furthest back, so that on axle four almost all tyres were excessively worn out, but also some front axles had worn-out tyres.

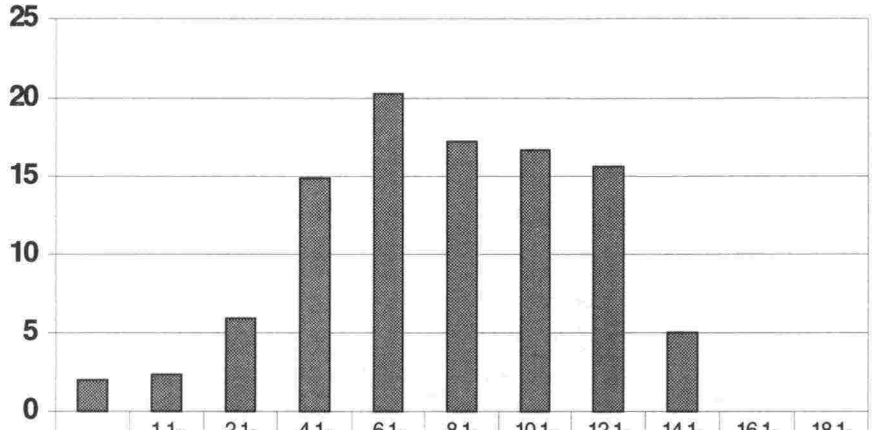
A Norwegian study, conducted in 1999 (TOI rapport 468/1999 Vogntog, kjøreatferd og kjøretøytilstand), examined some 2,600 vehicles. Of them, only 0.3 per cent (8) had an illegal front tyre, and the corresponding figure for drive tyres was 1.3 per cent. A total of 2,587 tyres on trailers were checked, and only 50 of them had too low tread depths (1.9 per cent). Based on this comparison, it seems that Finnish trucks and their tyres are in a worse condition. However, it should be noted that the Norwegian study only measured one tyre on a truck or trailer, and this means that the bad tyres on the rear axles or on dual wheels were ignored. In this study, the categorization “at least three worn-out tyres” was used in order to take account of the dual wheels, in particular.

5.1.3 Graphs



	0-1mm	1.1-2.0mm	2.1-4.0mm	4.1-6.0mm	6.1-8.0mm	8.1-10.0mm	10.1-12.0mm	12.1-14.0mm	14.1-16.0mm	16.1-18.0mm	18.1-20.0mm
tread depth (%)	0.2	0.6	5.2	9.6	19.0	23.6	23.2	14.9	2.9	0.6	0.0

Figure 1. Distribution of tread depths on single tyres, width under 350 mm (quantity: 478). Average tread depth 9.7 mm.



	0-1mm	1.1-2.0mm	2.1-4.0mm	4.1-6.0mm	6.1-8.0mm	8.1-10.0mm	10.1-12.0mm	12.1-14.0mm	14.1-16.0mm	16.1-18.0mm	18.1-20.0mm
tread depth (%)	2.0	2.3	5.9	14.9	20.3	17.2	16.7	15.6	5.0	0.0	0.0

Figure 2. Distribution of tread depths on single tyres, width 350 mm or over (quantity: 558). Average tread depth 9.1 mm.

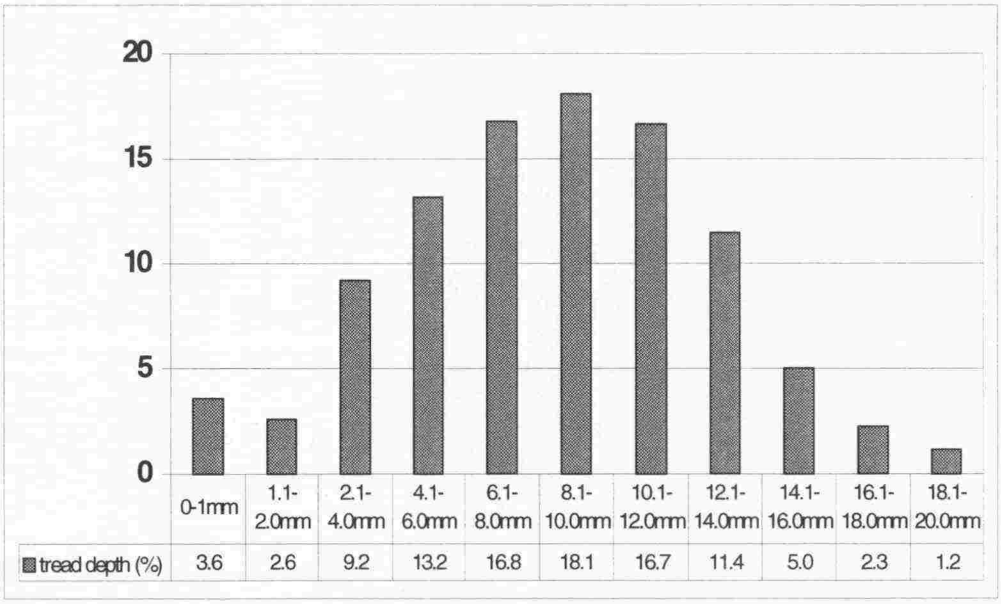


Figure 4. Distribution of tread depths on inner dual tyres (quantity: 1,036). Average tread depth 9.0 mm.

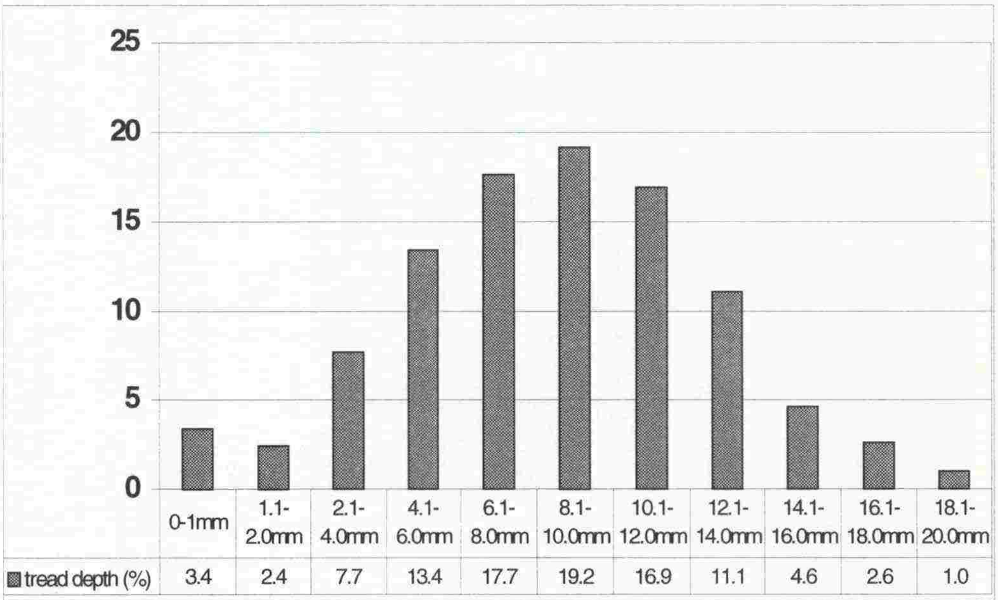


Figure 4. Distribution of tread depths on inner dual tyres (quantity: 1,036). Average tread depth 9.0 mm.

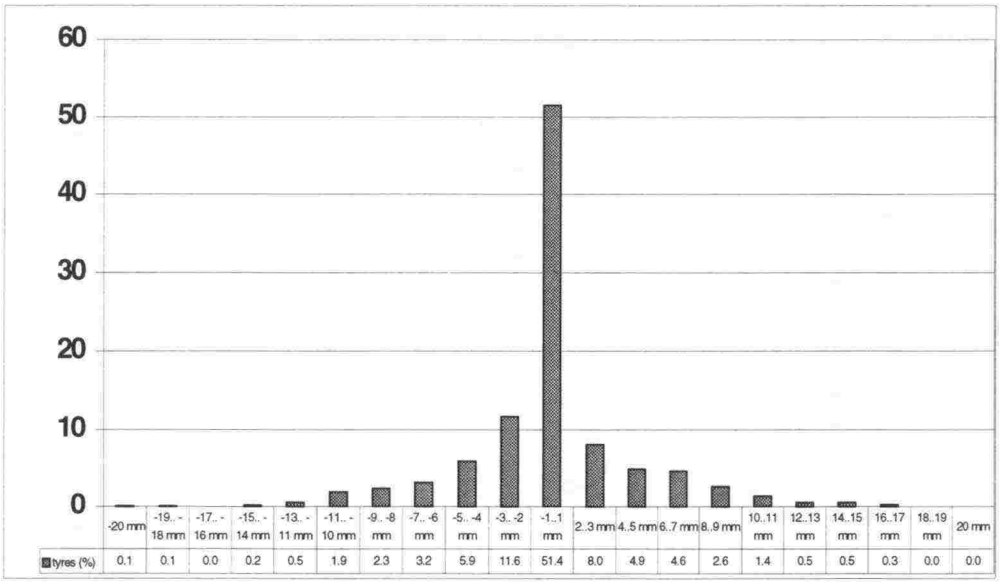


Figure 5. Distribution of differences in tread depth between outer and inner dual tyres. Average difference: –0.05 mm.

5.2 Brake temperatures

5.2.1 Theoretical considerations

When a vehicle is braking, the speed is reduced in a way desired by the driver. The mass and velocity of the tractor and trailer combination create kinetic energy that must be affected in order to achieve braking. The amount of energy is constant, which means that kinetic energy cannot be eliminated, it must be transformed. In brakes, this happens by transforming kinetic energy into thermal energy through friction. The materials used in brakes conduct heat effectively, and brakes often have cooling fins to boost heat dissipation. The better the above-mentioned issues have been taken into account, the more effective the braking system. Even on a car, the instantaneous energy transformed into heat is hundreds of kilowatts. For example, to brake a vehicle weighing 2,300 kg from the speed of 110 km/h (30.5 m/s ? 0 m/s) at a deceleration of 7.6 m/s^2 means an average braking effect of about 260 kW for four seconds. Correspondingly, if a truck weighing 22,500 kg is stopped from the speed of 85 km/h (23.6 m/s ? 0 m/s) at a deceleration of 5.5 m/s^2, the brakes are heated with an average effect of 1,470 kW for 4.3 seconds. It is natural that after such an emergency braking, the temperature of the brakes may be very high (hundreds of degrees Celsius).

The lifespan and friction coefficient of the brakes deteriorate when the brakes overheat. An increase of 300°C may increase the friction coefficient, but at higher temperatures, brake force may deteriorate with ordinary friction materials. An isolated instance of braking usually does not increase temperatures this high, but repeated or constant braking (e.g. in mountains) may increase the temperatures at dangerously high levels. If the brake system is too warm already when the braking starts, it is possible that the driver inadvertently allows the brakes to overheat. In normal driving, a temperature of a few dozen degrees

Celsius must be regarded as quite normal, especially after stopping. A high brake temperature may be indicative of brake drag. This type of constant braking is harmful to the brakes, and it wastes fuel.

In hydraulic brakes (mainly used on lighter vehicles), the impact of the brake fluid boiling point on brake force must also be taken into account. For example, the boiling point of brake fluid conforming to the new DOT 5 classification is 292°C in the absence of condensation. The boiling point declines considerably with the increasing water content, and thus boiling brake fluid may become a long-term factor reducing brake force.

Today, heavy vehicles are mainly equipped with drum brakes. However, the use of disc brakes is expanding rapidly because they cool off faster and their maintenance is easier. Disc brake systems are also lighter in weight. The energy needed for breaking comes from compressed air, since the force applied by the driver on the brake pedal and over the long brake line is not sufficient to cause braking on heavy vehicles. The brakes on the trailer must also be connected to the truck, and this is best done through a pneumatic system. It is typical of heavy vehicles used for goods transport that their loads vary greatly. This fact places certain demands on the distribution of brake force. In theory, the latter should be adjusted for each axle, depending on the load. A system that is load-sensitive adjusts brake force on each axle and for each load. This adjustment may take place, for example, depending on the depression of the suspension. More up-to-date solutions may take account of the wear of the brake pads. This system aims at controlling brake pad wear, thus optimizing the vehicle's maintenance intervals. While an overwhelming majority of brake heat is dissipated into air, some heat is also conducted through the metal structures of the axles. Some heat ends up in the tyres, through either air or the rim.

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5.2.2 Measurement results

The analysis was started by categorizing the material according to brake temperatures, which were categorized at ten-degree intervals. The lower and higher temperatures were categorized on a wider scale, owing to a low number of observations. For practical purposes, the temperature of the left front brake was adopted as the categorization criterion because it was measured first and had not cooled off yet. The division was employed in order to examine the connection between brake temperature and tyre temperature, since tyre pressures increase with temperature (see Chapter 5.4).

Graphs were made concerning the link between brake and tyre temperatures by truck type (see Chapter 5.2.3). The graphs were drawn up based on mean values, making it possible to rule out possible deviations or special circumstances. The graphs show the trends in tyre and brake temperatures. All graphs indicate that tyre temperature increases with brake temperature up until about 40°C, whereupon the tyres do not heat up anymore. On trailers, the tyres warm up less.

The measurement results did not specify whether the vehicles had drum or disc brakes. This factor has a major impact on brake temperatures.

5.2.3 Graphs

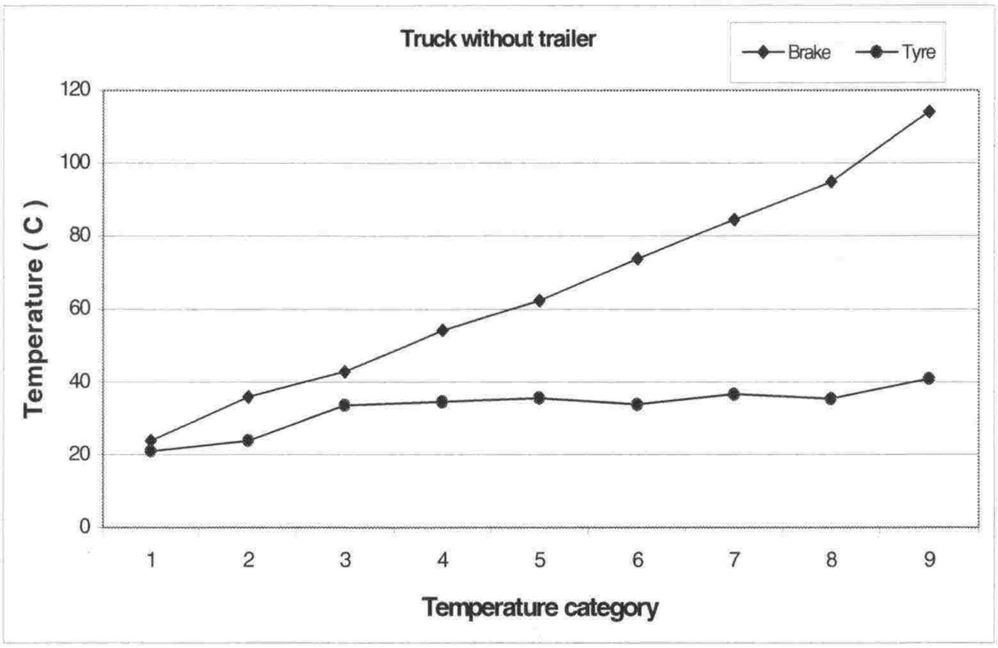


Figure 6. Comparison of brake and tyre temperatures on trucks without a trailer. The temperature category on the X-axis refers to the temperature of the left brake on the truck front axle.

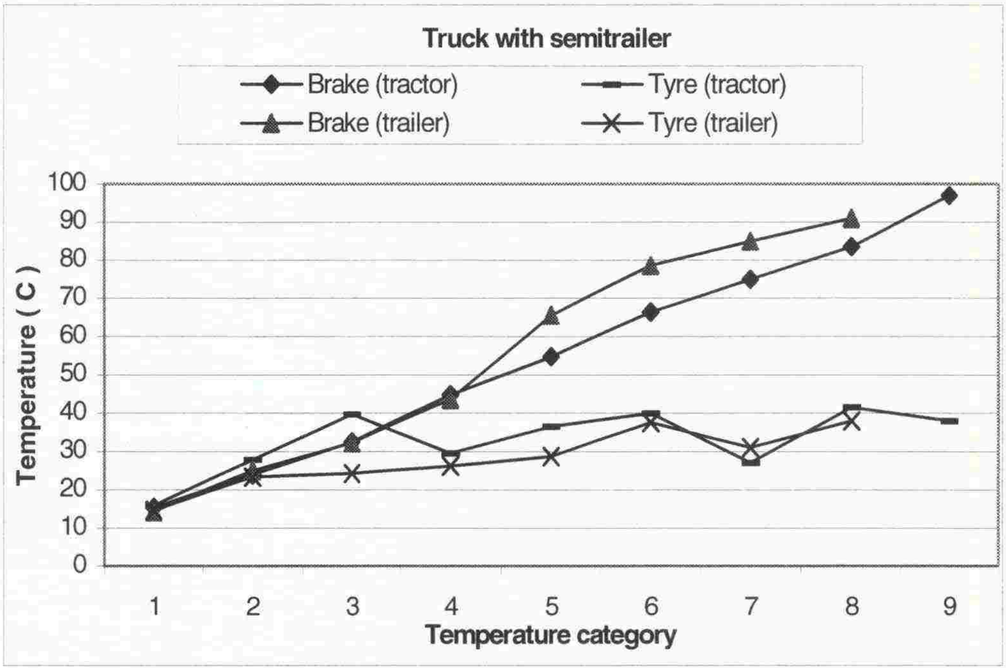


Figure 7. Comparison of brake and tyre temperatures on trucks with a semitrailer. The temperature category on the X-axis refers to the temperature of the left brake on the truck front axle.

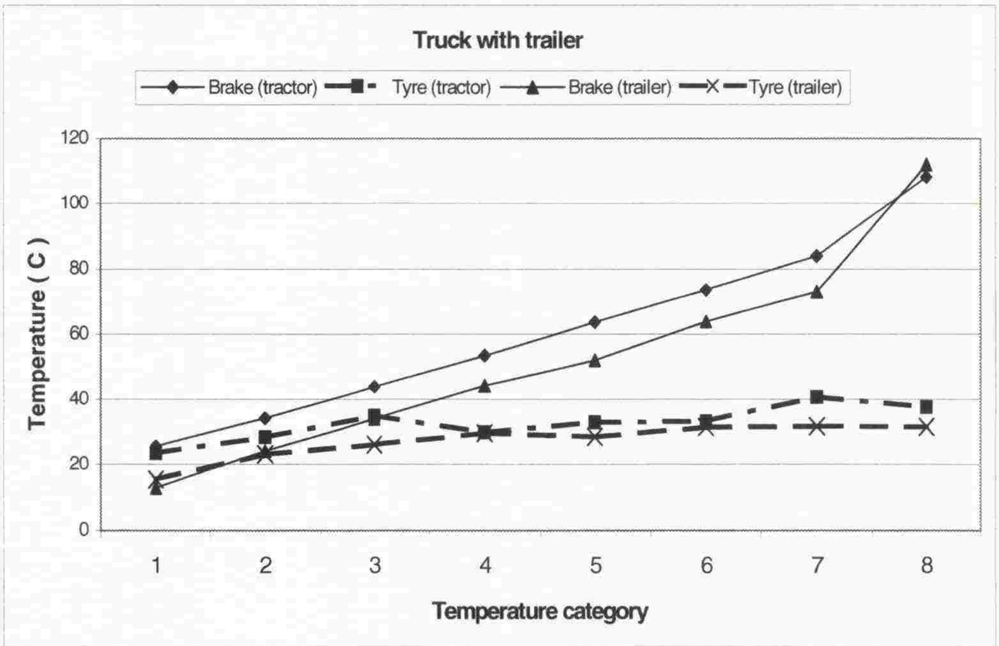


Figure 8. Comparison of brake and tyre temperatures on truck and trailer combinations. The temperature category on the X-axis refers to the temperature of the left brake on the truck front axle.

5.3 Categorization of the material by load

The material was also categorized according to the load/capacity ratio (empty, half-full, full), and averages of tyre pressures, tyre temperatures and brake temperatures were calculated for each category. This made it possible to compare brake temperatures with different load/capacity ratios. Comparison disregarded all such cases where the vehicles had been parked for over ten minutes prior to measurement, enabling the brakes to cool off.

For clarity, comparisons were made concerning empty and full vehicles only. The graphs in Chapter 5.3.1 clearly indicate how the brake and tyre temperatures are contingent on the load. Both extremities, cold or warm brakes and tyres, involved completely empty or full vehicles, respectively.

Averages of tyre pressures, tyre temperatures and brake temperatures were also calculated by truck type, depending on whether the vehicles had loads. On fully loaded trailerless trucks and semitrailer trucks, the brakes were on average some 20°C warmer and tyres 15-20°C warmer than on empty vehicles. On trucks with a trailer, the differences were somewhat smaller, 10-20°C in brakes and about 10°C in tyres. Tyre pressures corresponded to tyre temperatures: the warmer the tyres, the higher the tyre pressures.

As stated in Chapter 5.2 above, braking transforms kinetic energy into thermal energy. Because a fully loaded truck has more mass than an equivalent empty vehicle, the amount of thermal energy produced is larger, and it is natural that the brakes are on average warmer.

When analysing the measurement results, it transpired that on some vehicles, one or several brakes were much warmer than the rest of the brakes. In all likelihood, this suggests a faulty brake. The brake may drag, thus constantly slowing down the tyre to some degree, although the driver is not applying the brake. In such cases, the brake heats up and wears out rapidly. Of all the vehicles measured, six had a temperature difference of 40°C minimum between the front axle brakes.

As far as these results are concerned, however, the measurement situation should be taken into account. The material does not indicate how much the driver had to brake before making the stop. The amount of braking namely depended on whether the stop was along a motorway, following a downhill slope or on top of a hill, etc. Nor does the material give information about the type of place where the vehicle was measured. Therefore, the material cannot be categorized or compared in terms of location.

Another factor that has a bearing on the issue is the driving style. If the style is aggressive, the brakes have to endure much wear. On the other hand, a steady and consistent driving style enables better fuel economy and, as an additional benefit, saves the brakes as well. The load/capacity ratio or the purpose of truck cannot accurately indicate the weight of the load, a fact that produces additional deviation in the results. However, there was enough material to make tentative analyses and to see the increasing brake and tyre temperatures by load/capacity ratio. Account should also be taken of the type of brake (disc or drum), but this information was not available.

5.3.1 Graphs

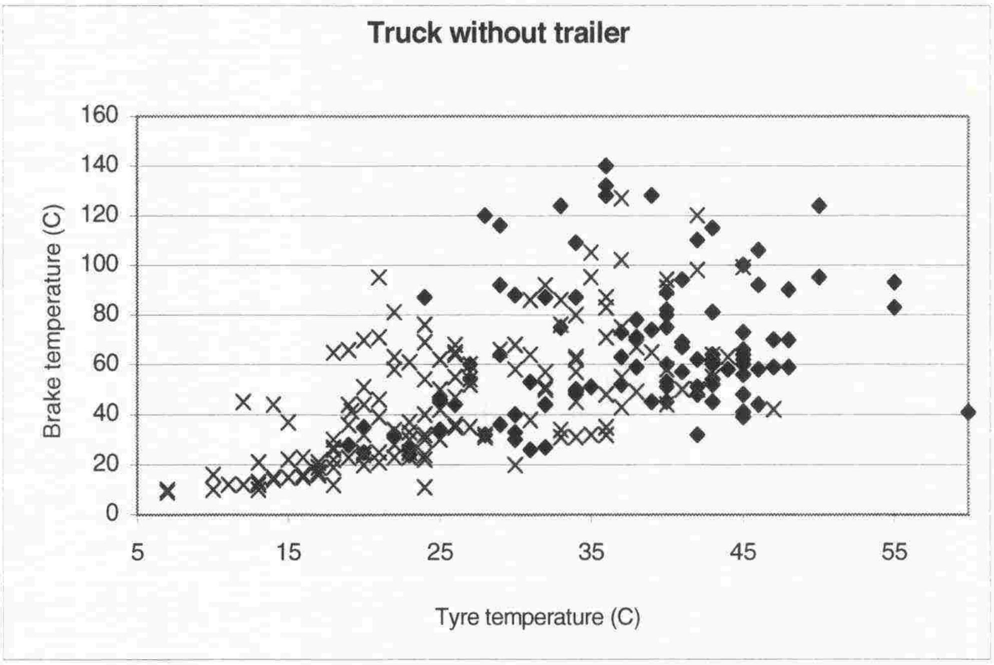


Figure 9. Brake and tyre warming on trucks without trailer – empty and full load. A cross denotes a full load, a diamond an empty truck.

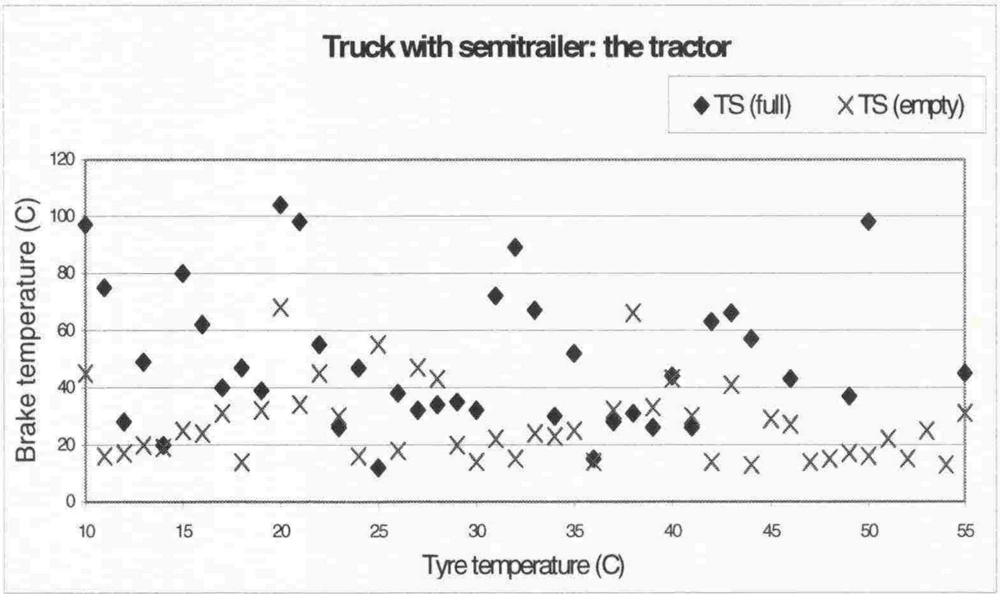


Figure 10. Trucks with a semitrailer: brake and tyre warming on the tractor – empty and full load.

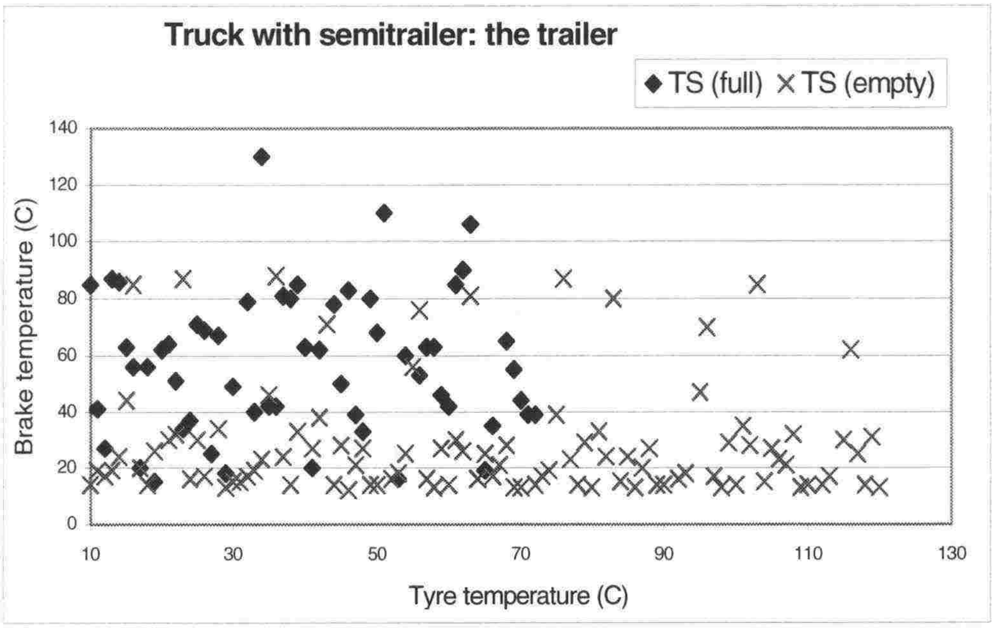


Figure 11. Trucks with a semitrailer: brake and tyre warming on the trailer – empty and full load.

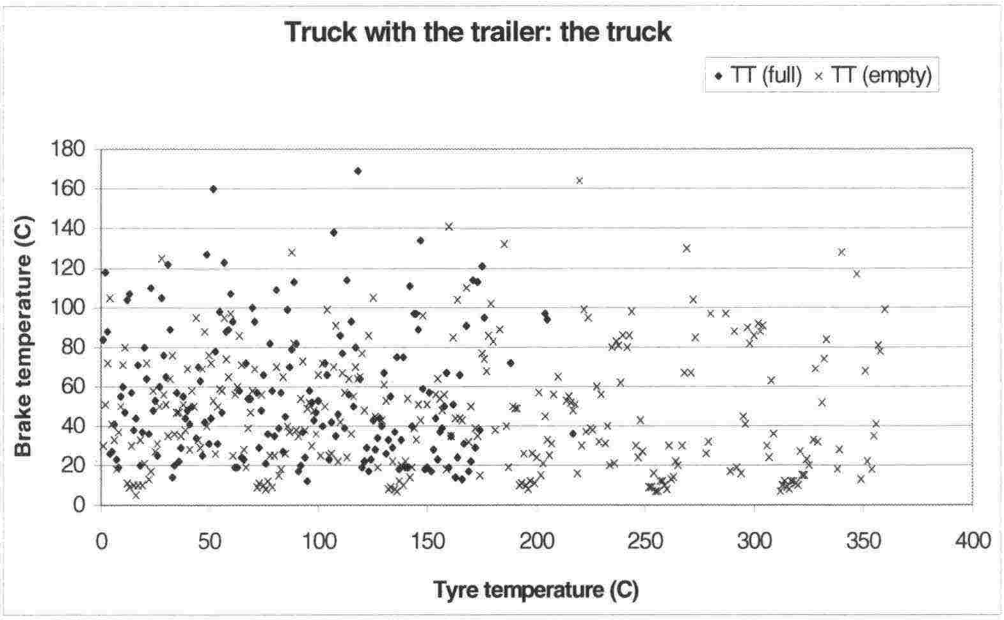


Figure 12. Trucks with a trailer: brake and tyre warming on the truck – empty and full load.

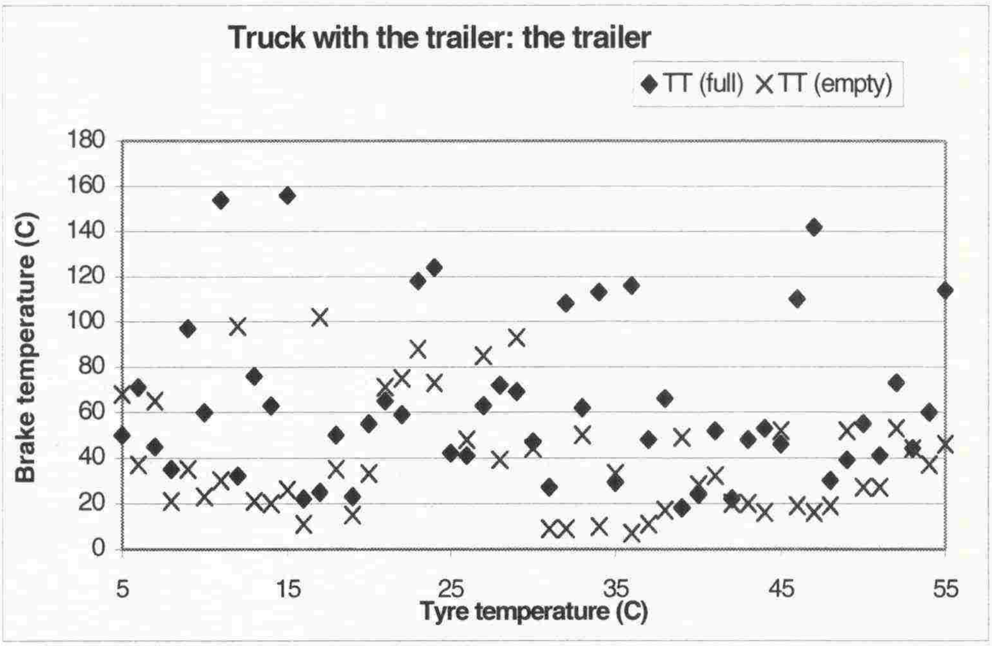


Figure 13. Trucks with a trailer: comparison of brake and tyre temperatures on the trailer – empty and full load.

5.4 Tyre pressures

5.4.1 Theoretical considerations

Tyre pressures affect the tyre's absorption properties and forces directed at the road. When the tyre pressure is too low, the tyre bends more, it warms and its lifespan shortens. This results from a higher rolling resistance associated with lower tyre pressures. Moreover, an underinflated tyre increases fuel consumption and makes steering more difficult.

The tyre pressure and load affect the pressure and area of contact the tyre has on the road. When the tyre pressure is low, the contact area is large. Parts of the tread come in and out of contact with the road surface at a sharp angle. The result is the so-called 'sweep phenomenon', whereby the relative speed of tread particles is faster than if the tyre pressure was higher; consequently, the tyre wears out more.

On heavy vehicles, tyre pressures should be adjusted to axle masses, without forgetting the purpose of the vehicle. High tyre pressures should be used when travelling long distances at a high speed, while low pressures are in order on, e.g. rough roads, such as in soil transport.

In rough terms, it is conceivable that the tyre pressure is of the same order as the pressure directed at the road surface. From the viewpoint of road structures and vehicle performance, optimal tyre pressures would be the best alternative. A high tyre pressure enhances fuel economy and, to some degree, tyre durability, but it increases the forces directed at the road and weakens the contact between the tyre and road surface.

On heavy vehicles, dual wheels are generally used on drive and load-bearing axles. Dual wheels have two tyres at the ends of the axle, carrying the load. This reduces the surface pressure, and the burden on the road is smaller. Each tyre in a dual set should have approximately the same pressure, so that the strain on the road would be more evenly distributed and that the surface pressure would be lower. Equivalent pressures also distribute load evenly between the tyres, a fact that is beneficial for tyre wear and fitting. Also for driving comfort, it is important that the tyres on a given axle have equal air pressures.

When the vehicle is moving, tyre pressures change due to tyre warming. The tyre warms through deformation, lateral and longitudinal forces and the heat, e.g. from the brakes. However, if the skid of the tyre is not extensive, the tyre surface temperature remains close to that of the road surface, since contact with the road and the moving air cool down the tyre. The temperature of the tyre sidewalls, however, increases in drive. When the road and air temperature is about +10°C, the temperature of the tyre sidewalls of a car rises to about +45°C in normal highway travel, and a similar effect takes place in the winter as well: the tread temperature is close to zero degrees Celsius in drive, while the sidewalls are clearly warm.

Once the vehicle has stopped, heat starts to conduct from the sidewalls to the tread, and sometimes heat is also conducted from the brakes through the rim. This process of course cools off the sidewalls, as heat is conducted to the tread. In the winter, this is easy to notice on fresh snow: after the vehicle has stopped, the snow on the tread starts to melt, despite the ambient temperature, which is below freezing. Since the thermal conductivity of rubber is poor, it takes several minutes for the temperature differences to balance out.

Thus, it is normal that after the vehicle has stopped, the tyre still warms up for a few minutes in the absence of cooling air. This warming is mainly attributable to the heat conducted from the tyre sidewalls and brakes. The increase in the temperatures of the tyre and, most notably, of the rim, warms up the air inside the tyre. In simple terms, there is an isochoric change of state in the tyre, i.e. the volume does not change.

According to the general gas state equation:
$pV = nRT$,
where
p = pressure
V = volume (constant)
T = temperature
n = molar count (constant)
R = molar gas constant = 8.3145 J / (mol*K)

The formula shows that when the volume is constant, a growing temperature will increase the pressure.

Take a typical truck tyre, for example (size 315/80R22.5):
Initial temperature = 20°C = 293K
New temperature = 40°C = 313K
Initial pressure = 7.5 bar

Then, the change in pressure Δp
= p[2] – p[1]
= p[1] * (T[2] / T[1] – 1)
= 7.5 bar * (313K / 293K – 1)
= 0.15 bar

As stated above, an underinflated tyre warms up considerably. Its pressure also increases somewhat, but not enough as to compensate for the too low pressure.

From the analysis viewpoint, and for the reasons given above, it has only been possible to use measurements that presumably were conducted not too long after the vehicle had stopped. The measurement report does not specify whether measurement was done from the tread groove or surface layer.

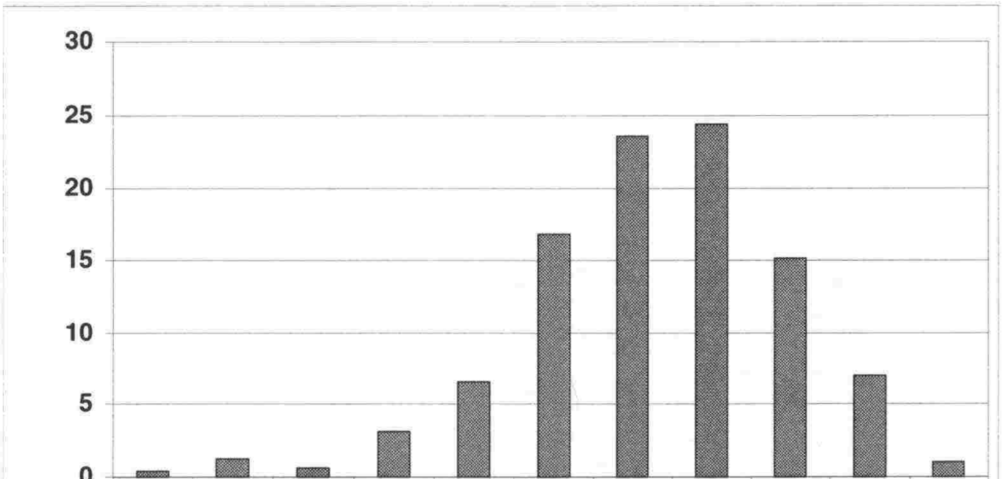
Additional information:
Juurikkala, Jussi. *Autokirja*. 1988.
Stumpf, Horst. *Handbuch der Reifentechnik.* Springer Technik 1997. 210 p.
Reimpell, Jörnsen & Sponagel, Peter. *Fahrwerktechnik: Reifen und Räder.* Vogel 1981. 266 p.
Mitschke, Manfred. *Dynamik der Kraftfahrzeuge.* 3rd Edition. 1997. 326 p.
The Tire-Pavement Interface Symposium, 5-6 June 1985. ASTM 929. ASTM 1986. 310 p.

5.4.2 Measurement results

The measurements provided quite a comprehensive view of truck tyre pressures and pressure differences between dual tyres. Summaries (see Appendix 3) and distribution graphs (see Chapter 5.4.3) were made of the results. The distribution graphs examined tyre pressures categorized by tyre width. The tyres were divided into single tyres with widths under or over 350 mm and dual tyres. The distribution graphs also incorporate comparison of dual-tyre pressures.

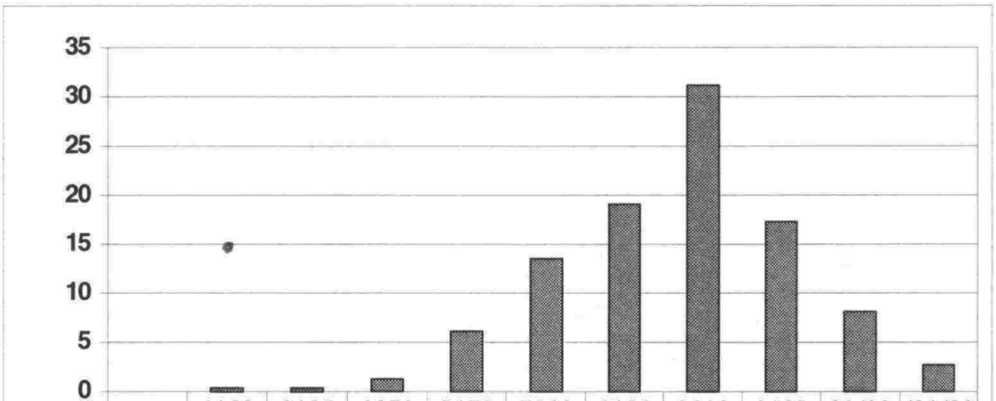
According to this material, about 80 per cent of the tyre pressures ranged from 7.0 to 9.5 bar, depending on the tyre width and whether a single or dual tyre was in question. The rest of the tyres were either clearly underinflated or somewhat overinflated. As a rule, single tyres had higher pressures than dual tyres. On single tyres, whose width was under 350 mm, average pressure was 8.4 bar; on tyres over 350 mm wide the pressure was 8.6 bar, while dual tyres had 7.9 bar. In 42 per cent of the dual tyres, the pressure difference between the outer and inner tyre was less than 0.5 bar, and in 92 per cent of the cases, the difference was less than 2 bar. This is a positive finding because it is important that pressure differences between dual tyres are small so that the wheels can distribute the load on the road more evenly. This is positive for another reason, too: because checking the pressure of the inner tyres is difficult, it seemed likely that differences would have been greater and more widespread. Underinflated tyres were relatively more common among dual tyres.

5.4.3 Graphs



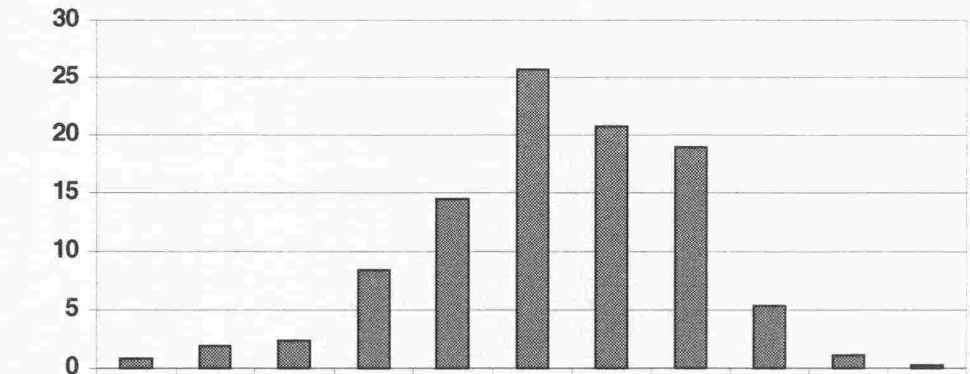
	0-4.0 bar	4.1-6.0 bar	6.1-6.5 bar	6.6-7.0 bar	7.1-7.5 bar	7.6-8.0 bar	8.1-8.5 bar	8.6-9.0 bar	9.1-9.5 bar	9.6-10.0 bar	10.1-12.0 bar
tyres (%)	0.4	1.3	0.6	3.2	6.5	16.8	23.6	24.4	15.2	6.9	1.1

Figure 14. Distribution of tyre pressures on single tyres, width under 350 mm (quantity: 478). Average tyre pressure 8.4 bar.



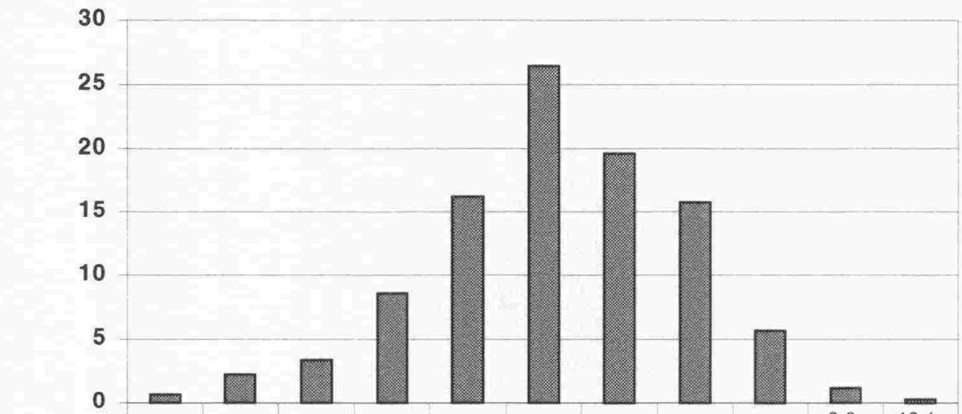
	0-4.0 bar	4.1-6.0 bar	6.1-6.5 bar	6.6-7.0 bar	7.1-7.5 bar	7.6-8.0 bar	8.1-8.5 bar	8.6-9.0 bar	9.1-9.5 bar	9.6-10.0 bar	10.1-12.0 bar
tyres (%)	0.0	0.4	0.4	1.3	6.1	13.5	19.1	31.2	17.3	8.1	2.7

Figure 15. Distribution of tyre pressures on single tyres, width 350 mm or over (quantity: 558). Average tyre pressure 8.6 bar.



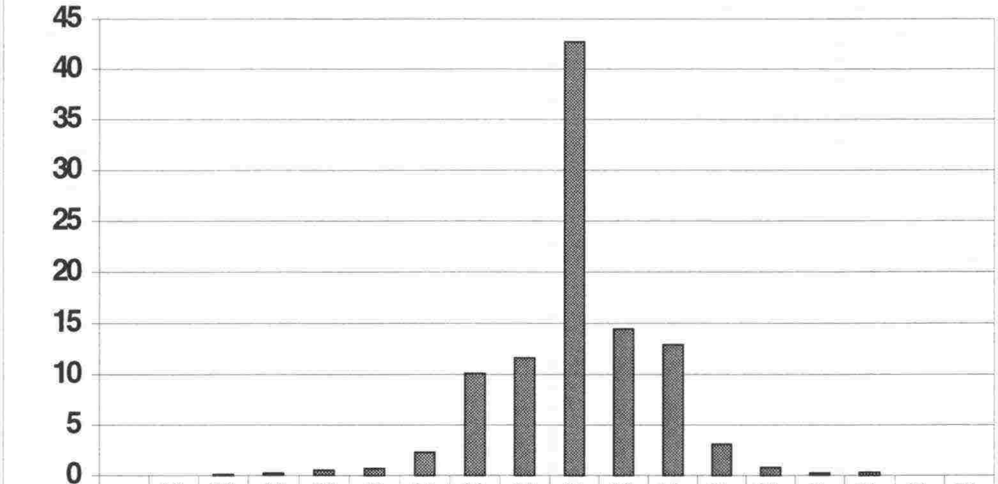
	0-4.0 bar	4.1-6.0 bar	6.1-6.5 bar	6.6-7.0 bar	7.1-7.5 bar	7.6-8.0 bar	8.1-8.5 bar	8.6-9.0 bar	9.1-9.5 bar	9.6-10.0 bar	10.1-12.0 bar
tyres (%)	0.8	1.9	2.4	8.4	14.5	25.7	20.7	18.9	5.3	1.1	0.3

Figure 16. Distribution of tyre pressures on outer dual tyres (quantity: 1,110 / 1,105 measured). Average tyre pressure 7.9 bar.



	0-4.0 bar	4.1-6.0 bar	6.1-6.5 bar	6.6-7.0 bar	7.1-7.5 bar	7.6-8.0 bar	8.1-8.5 bar	8.6-9.0 bar	91-9.5 bar	9.6-10.0 bar	10.1-12.0 bar
tyres (%)	0.7	2.2	3.4	8.6	16.2	26.4	19.6	15.7	5.7	1.2	0.3

Figure 17. Distribution of tyre pressures on inner dual tyres (quantity: 1,110 / 1,036 measured). Average tyre pressure 7.9 bar.



	.. -8.1	-8.0.. -7.1	-7.0.. -6.1	-6.0.. -5.1	-5.0.. -4.1	-4.0.. -3.1	-3.0.. -2.1	-2.0.. -1.1	-1.0.. -0.6	-0.5.. 0.5	0.6.. 1.0	1.1.. 2.0	2.1.. 3.0	3.1.. 4.0	4.1.. 5.0	5.1.. 6.0	6.1.. 7.0	7.1.. 8.0
tyres (%)	0.0	0.0	0.1	0.2	0.5	0.7	2.3	10.1	11.7	42.7	14.5	12.9	3.1	0.8	0.2	0.3	0.0	0.0

Figure 18. Distribution of differences in air pressure between outer and inner dual tyres. Average difference 0.03 bar.

5.5 Categorization of the material by tyre temperature

The material was also categorized according to tyre temperature; this was done based on the left front tyre. Tyre temperatures and pressures were analysed through graphs in order to find a correlation between tyre temperature and pressure.

The graphs were drawn up by calculating mean values of the categorized tyre temperatures and pressures in order to rule out deviations due to possible technical malfunction. The graphs indicate that tyre pressures increase with tyre temperature, but, in some cases, this uptrend levels off at the far end of the diagram. This is such a minor change that it may result from the small sample size.

5.5.1 Graphs

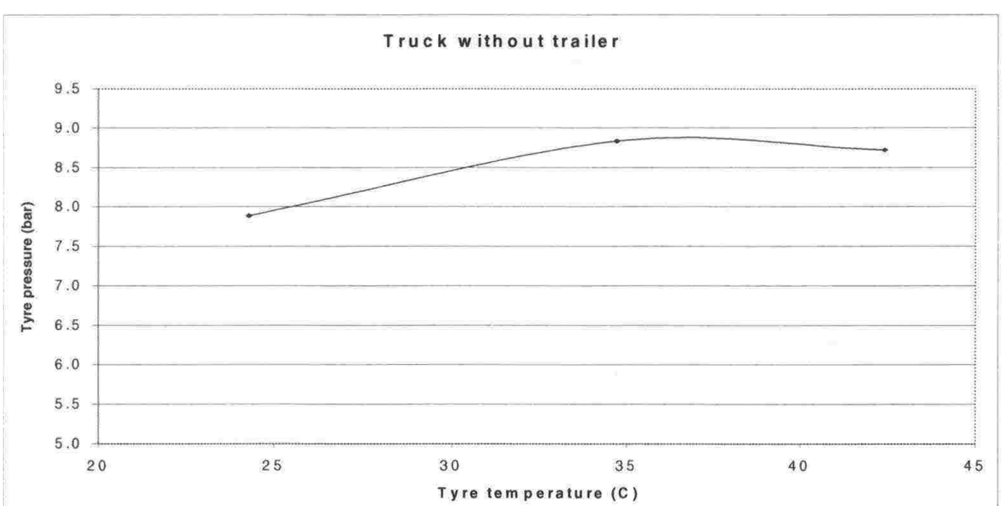


Figure 19. The connection between tyre temperature and tyre pressure on trucks without a trailer.

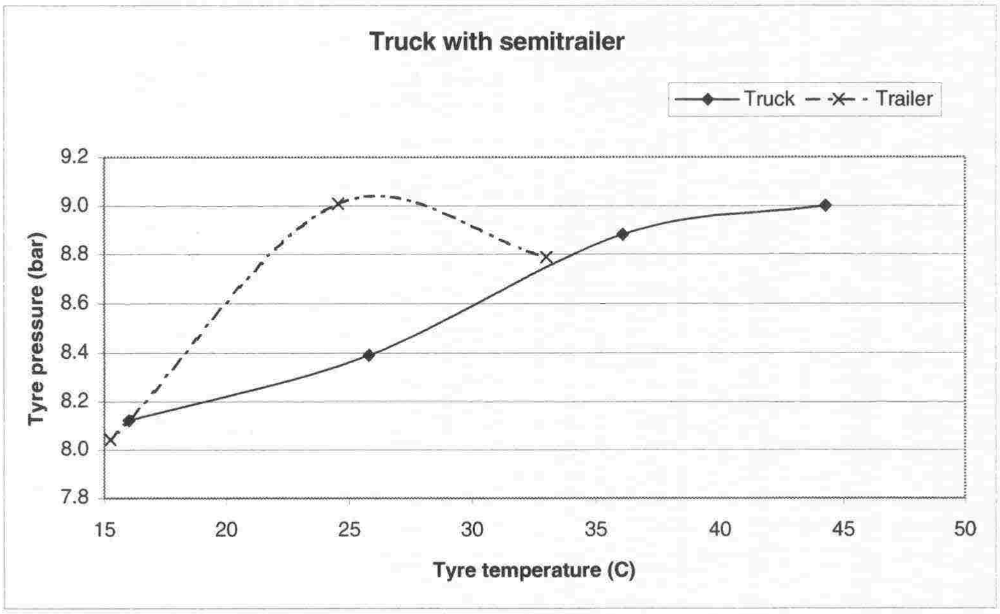


Figure 20. The connection between tyre temperature and tyre pressure on trucks with a semitrailer.

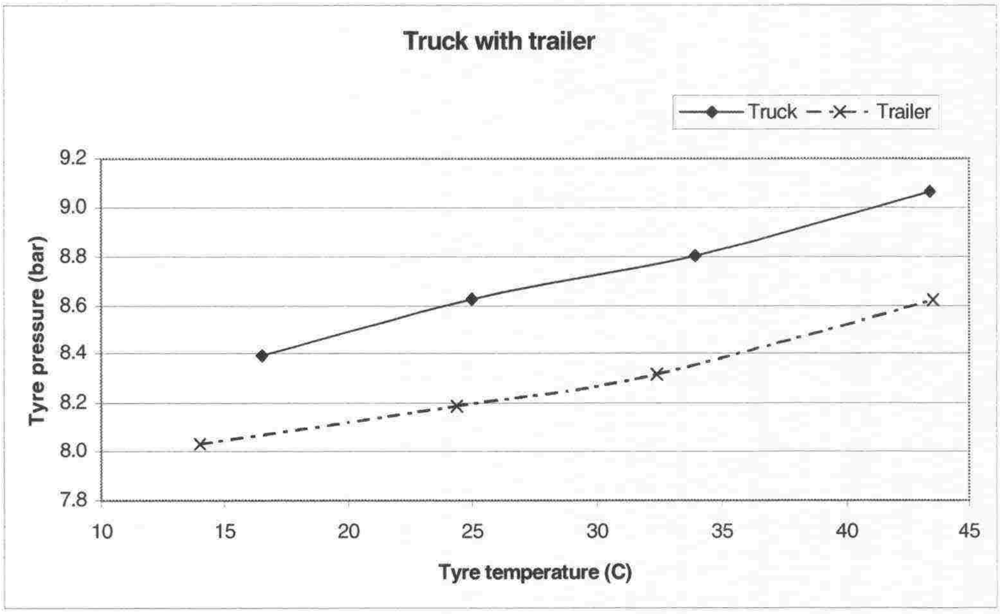


Figure 21. The connection between tyre temperature and tyre pressure on trucks with a trailer.

6 CONCLUSIONS

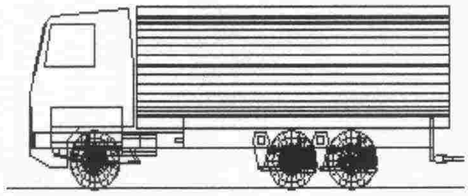
A field study of this type is toilsome to implement. While a sample consisting of about two hundred vehicles, categorized into three groups, does not allow for drawing any far-reaching conclusions, it gives some tentative information. In addition, experiences of the sampling method are useful for future studies of this kind. To yield the best possible outcome, a study should incorporate accurate information about the measurement sites because tyre and brake temperatures are affected by the site. For example, motorway rest areas or warehouse terminals in built-up areas give different results. In addition, the amount of time between stopping and measurement should be constant.

The study suggests that tyre pressures were reasonably well at the right level. About 80 per cent of the pressures were between 7.0-9.5 bar, depending on tyre width and type (single/dual). The rest were either considerably underinflated or somewhat overinflated. Dual wheels had relatively more underinflated tyres, compared to single wheels. In 42 per cent of the dual wheels, the pressure difference between the outer and inner tyre was less than 0.5 bar, and in 92 per cent of the cases, the difference was less than 2 bar. This is a positive finding. It is important that pressure differences between dual tyres are small, so that the load on the road and tyre wear would be evenly distributed.

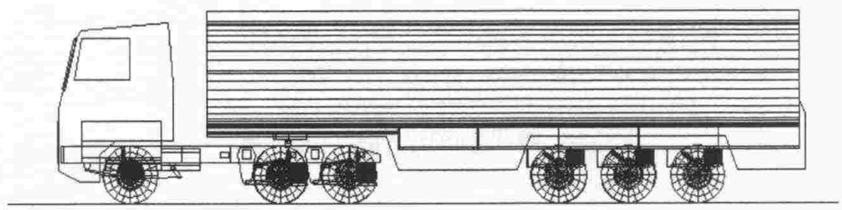
In terms of the depth of tread, the tyres studied were usually in a good condition. However, 5.1 per cent of the trucks with trailers had at least three illegal or almost illegal tyres. While this result may be deemed good, comparison with a Norwegian study on truck and trailer combinations showed that Finnish trucks and trailers had somewhat worse tyres.

Unfortunately, it was impossible to utilize all measurements of tyre and brake temperatures in the analysis, owing to the long parking times of some vehicles prior to measurement. Moreover, the measurements did not specify whether the brakes were of the disc or drum type. In general terms, the temperatures were appropriate, and no major deviations between axles or tyres were found. For instance, only six cases showed temperature differences exceeding 40°C between the front axle brakes. The driving style has a great impact on tyre and brake temperatures. In addition, the total mass of a vehicle used for goods transport varies greatly depending on the load. Although the load was recorded in the material, it was impossible to form more detailed categories, mutually comparable in terms of location and load.

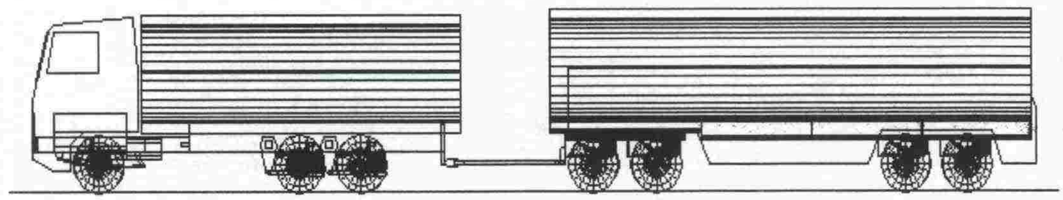
APPENDIX 1: ABBREVIATIONS USED IN THE REPORT



T = Truck without a trailer



TS = Truck with a semitrailer



TT = Truck with a trailer

APPENDIX 2: FIELD FORMS

1 TRUCK

Fill in all grey fields

Measurement site:

Date:

Measurers:

Make and model:		Reg. No.	Country:
Truck without trailer			T
Truck with trailer			TT
Truck with semitrailer			TS
Purpose (circle)	Raw material / Soil / Fuel Other (specify) :		
Load/capacity ratio (circle)	Full / Half-full / Empty		
Measured (circle)	After drive / Parked _____ minutes		

Axle 1

		Vehicle general condition: 0 1 2 3 (0 = substandard, 3= excellent) Other:			Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A				
Tyre brand and model					
Size					
Original / **R**etreaded	O / R		Drive?		O / R
Tread depth	mm				mm
Sidewall condition (0 = bad)	0 1 2 3	NB! Mark drive axles			0 1 2 3
Tyre pressure	bar	by putting a cross on the grey field			bar
Tyre temperature	C	**NB!** Mark bogie axles (connect relevant axles with pen)			C
Brake temperature	C				C

NB! If some part of inspection fails: explanation

Axle 2

Position **U**p / **D**own	U / D	Bolts			Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A				
Tyre brand and model					
Size					
Original / **R**etreaded	O / R	O / R	Drive?	O / R	O / R
Tread depth	mm	Mm		mm	Mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3		0 1 2 3	0 1 2 3
Tyre pressure	bar	bar		bar	bar
Tyre temperature	C	C		C	C
Brake temperature	C				C

Axle 3

Position **U**p / **D**own	U / D	Bolts			Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A				
Tyre brand and model					
Size					
Original / **R**etreaded	O / R	O / R	Drive?	O / R	O / R
Tread depth	mm	mm		mm	Mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3		0 1 2 3	0 1 2 3
Tyre pressure	bar	bar		bar	bar
Tyre temperature	C	C		C	C
Brake temperature	C				C

Axle 4

Position **U**p / **D**own	U / D	Bolts			Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A				
Tyre brand and model					
Size					
Original / **R**etreaded	O / R	O / R	Drive?	O / R	O / R
Tread depth	mm	mm		mm	Mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3		0 1 2 3	0 1 2 3
Tyre pressure	bar	bar		bar	bar
Tyre temperature	C	C		C	C
Brake temperature	C				C

Axle 5

Position **U**p / **D**own	U / D	Bolts			Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A				
Tyre brand and model					
Size					
Original / **R**etreaded	O / R	O / R	Drive?	O / R	O / R
Tread depth	mm	mm		mm	Mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3		0 1 2 3	0 1 2 3
Tyre pressure	bar	bar		bar	bar
Tyre temperature	C	C		C	C
Brake temperature	C				C

2 TRAILER

Fill in all grey fields

General condition of trailer:
0 1 2 3

(0 = substandard, 3= excellent)

Make and model:		Reg. No.	Country:
Semitrailer **ST** Full trailer **FT** Mid-axle trailer **MA**		Other:	
Purpose (circle)		Raw material / Soil/ Fuel Other (specify):	
Load/capacity ratio (circle)		Full / Half-full / Empty	

Axle 1

		Bolts		Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A			
Tyre brand and model				
Size				
Original / **R**etreaded	O / R	O / R	O / R	O / R
Tread depth	mm	mm	mm	mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
Tyre pressure	bar	bar	bar	bar
Tyre temperature	C	C	C	C
Brake temperature	C			C

Axle 2

		Bolts		Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A			
Tyre brand and model				
Size				
Original / **R**etreaded	O / R	O / R	O / R	O / R
Tread depth	mm	mm	mm	mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
Tyre pressure	bar	bar	bar	bar
Tyre temperature	C	C	C	C
Brake temperature	C			C

Axle 3

		Bolts		Bolts
Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A			
Tyre brand and model				
Size				
Original / **R**etreaded	O / R	O / R	O / R	O / R
Tread depth	mm	mm	mm	mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
Tyre pressure	bar	bar	bar	bar
Tyre temperature	C	C	C	C
Brake temperature	C			C

Axle 4

Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A	Bolts		Bolts
Tyre brand and model				
Size				
Original / **R**etreaded	O / R	O / R	O / R	O / R
Tread depth	mm	mm	mm	mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
Tyre pressure	bar	bar	bar	bar
Tyre temperature	C	C	C	C
Brake temperature	C			C

Axle 5

Suspension **L**eaf / **P**arabolic / **A**ir	L / P / A	Bolts		Bolts
Tyre brand and model				
Size				
Original / **R**etreaded	O / R	O / R	O / R	O / R
Tread depth	mm	mm	mm	mm
Sidewall condition (0 = bad)	0 1 2 3	0 1 2 3	0 1 2 3	0 1 2 3
Tyre pressure	bar	bar	bar	bar
Tyre temperature	C	C	C	C
Brake temperature	C			C

APPENDIX 3 : SUMMARY TABLES BASED ON THE MATERIAL

Key to the Tables in Appendix 3: tyre pressure 4.0 bar / 0 means that no tyres were found with pressures ranging between 0 and 4.0 bar. Accordingly, 7.5 bar / 2 means that two tyres matched the range 7.1-7.5 bar. In tread depth, 8 mm / 10 means that the range 6.1 mm-8.0 mm comprised 10 tyres (depth indicated as whole numbers).

Truck without trailer: summary

Axle 1 left; quantity: 41

Tyre pressure / bar	Quantity	Tread depth / mm	Quantity	Sidewall condition / 0=bad, 3=excellent	Quantity	Original / retreaded	Quantity
4.0	0	1	0	0	0	o	39
6.0	0	2	0	1	2	r	2
6.5	0	4	1	2	30		41
7.0	0	6	5	3	9		
7.5	2	8	10		41		
8.0	7	10	12				
8.5	8	12	9				
9.0	17	14	2				
9.5	6	16	2				
10.0	1	18	0				
12.0	0	20	0				
	41		41				

Axle 1 right 41

Tyre pressure / bar	Quantity	Tread depth / mm	Quantity	Sidewall condition / 0=bad, 3=excellent	Quantity	Original / retreaded	Quantity
4.0	0	1	0	0	0	o	39
6.0	0	2	0	1	0	r	2
6.5	0	4	1	2	39		41
7.0	1	6	3	3	2		
7.5	4	8	7		41		
8.0	5	10	9				
8.5	9	12	13				
9.0	10	14	7				
9.5	10	16	1				
10.0	1	18	0				
12.0	0	20	0				
	40		41				

Axle 2 left outer 41

4.0	0	1	0	0	0	o	22
6.0	1	2	0	1	5	r	19
6.5	0	4	0	2	28		41
7.0	5	6	3	3	8		
7.5	5	8	6		41		
8.0	10	10	10				
8.5	8	12	11				
9.0	8	14	5				
9.5	4	16	3				
10.0	0	18	2				
12.0	0	20	1				
	41		41				

Axle 2 left inner 36

4.0	0	1	0	0	0	o	20
6.0	1	2	0	1	4	r	16
6.5	3	4	0	2	25		36
7.0	1	6	3	3	7		
7.5	6	8	11		36		
8.0	9	10	5				
8.5	8	12	6				
9.0	5	14	6				
9.5	2	16	3				
10.0	0	18	1				
12.0	0	20	1				
	35		36				

Axle 2 right inner 36

4.0	0	1	0	0	0	o	18
6.0	0	2	0	1	7	r	18
6.5	2	4	4	2	26		36
7.0	1	6	1	3	3		
7.5	5	8	7		36		
8.0	9	10	4				
8.5	7	12	8				
9.0	7	14	7				
9.5	2	16	3				
10.0	0	18	1				
12.0	0	20	1				
	33		36				

Axle 2 right outer 41

4.0	0	1	0	0	0	o	21
6.0	1	2	0	1	7	r	20
6.5	2	4	2	2	31		41
7.0	2	6	4	3	3		
7.5	6	8	12		41		
8.0	11	10	6				
8.5	8	12	3				
9.0	6	14	8				
9.5	4	16	4				
10.0	0	18	1				
12.0	0	20	1				
	40		41				

Axle 3 left outer 17

4.0	0	1	0	0	0	o	7
6.0	0	2	0	1	4	r	10
6.5	0	4	5	2	12		17
7.0	1	6	2	3	1		
7.5	2	8	6		17		
8.0	4	10	2				
8.5	4	12	2				
9.0	5	14	0				
9.5	1	16	0				
10.0	0	18	0				
12.0	0	20	0				
	17		17				

Axle 2 left inner 8

4.0	1	1	1	0	0	o	3
6.0	0	2	1	1	2	r	4
6.5	0	4	0	2	5		7
7.0	0	6	1	3	0		
7.5	0	8	2		7		
8.0	2	10	2				
8.5	3	12	1				
9.0	1	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	7		8				

Axle 3 right inner 8

4.0	0	1	0	0	0	o	1
6.0	0	2	0	1	4	r	7
6.5	0	4	0	2	4		8
7.0	0	6	1	3	0		
7.5	1	8	3		8		
8.0	1	10	3				
8.5	3	12	1				
9.0	2	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	7		8				

Axle 3 right outer 17

4.0	0	1	1	0	0	o	5
6.0	0	2	0	1	3	r	12
6.5	0	4	3	2	14		17
7.0	1	6	4	3	0		
7.5	0	8	3		17		
8.0	4	10	4				
8.5	7	12	1				
9.0	5	14	1				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	17		17				

Axle 4 left outer 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 4 left inner 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 4 right inner 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 4 right outer 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Semitrailer tractor: summary

Axle 1 left, Quantity: 41

Tyre pressure / bar	Quantity	Tread depth / mm	Quantity	Sidewall condition / 0=bad, 3=excellent	Quantity	Original / retreaded	Quantity
4.0	0	1	0	0	0	o	39
6.0	0	2	0	1	2	r	2
6.5	0	4	1	2	30		41
7.0	0	6	5	3	9		
7.5	2	8	10		41		
8.0	7	10	12				
8.5	8	12	9				
9.0	17	14	2				
9.5	6	16	2				
10.0	1	18	0				
12.0	0	20	0				
	41		41				

Axle 1 right 41

Tyre pressure / bar	Quantity	Tread depth / mm	Quantity	Sidewall condition / 0=bad, 3=excellent	Quantity	Original / retreaded	Quantity
4.0	0	1	0	0	0	o	39
6.0	0	2	0	1	0	r	2
6.5	0	4	1	2	39		41
7.0	1	6	3	3	2		
7.5	4	8	7		41		
8.0	5	10	9				
8.5	9	12	13				
9.0	10	14	7				
9.5	10	16	1				
10.0	1	18	0				
12.0	0	20	0				
	40		41				

Axle 2 left outer 41

4.0	0	1	0	0	0	o	22
6.0	1	2	0	1	5	r	19
6.5	0	4	0	2	28		41
7.0	5	6	3	3	8		
7.5	5	8	6		41		
8.0	10	10	10				
8.5	8	12	11				
9.0	8	14	5				
9.5	4	16	3				
10.0	0	18	2				
12.0	0	20	1				
	41		41				

Axle 2 left inner 36

4.0	0	1	0	0	0	o	20
6.0	1	2	0	1	4	r	16
6.5	3	4	0	2	25		36
7.0	1	6	3	3	7		
7.5	6	8	11		36		
8.0	9	10	5				
8.5	8	12	6				
9.0	5	14	6				
9.5	2	16	3				
10.0	0	18	1				
12.0	0	20	1				
	35		36				

Axle 2 right inner 36

4.0	0	1	0	0	0	o	18
6.0	0	2	0	1	7	r	18
6.5	2	4	4	2	26		36
7.0	1	6	1	3	3		
7.5	5	8	7		36		
8.0	9	10	4				
8.5	7	12	8				
9.0	7	14	7				
9.5	2	16	3				
10.0	0	18	1				
12.0	0	20	1				
	33		36				

Axle 2 right outer 41

4.0	0	1	0	0	0	o	21
6.0	1	2	0	1	7	r	20
6.5	2	4	2	2	31		41
7.0	2	6	4	3	3		
7.5	6	8	12		41		
8.0	11	10	6				
8.5	8	12	3				
9.0	6	14	8				
9.5	4	16	4				
10.0	0	18	1				
12.0	0	20	1				
	40		41				

Axle 3 left outer 17

4.0	0	1	0	0	0	o	7
6.0	0	2	0	1	4	r	10
6.5	0	4	5	2	12		17
7.0	1	6	2	3	1		
7.5	2	8	6		17		
8.0	4	10	2				
8.5	4	12	2				
9.0	5	14	0				
9.5	1	16	0				
10.0	0	18	0				
12.0	0	20	0				
	17		17				

Axle 2 left inner 8

4.0	1	1	1	0	0	o	3
6.0	0	2	1	1	2	r	4
6.5	0	4	0	2	5		7
7.0	0	6	1	3	0		
7.5	0	8	2		7		
8.0	2	10	2				
8.5	3	12	1				
9.0	1	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	7		8				

Axle 3 right inner 8

4.0	0	1	0	0	0	o	1
6.0	0	2	0	1	4	r	7
6.5	0	4	0	2	4		8
7.0	0	6	1	3	0		
7.5	1	8	3		8		
8.0	1	10	3				
8.5	3	12	1				
9.0	2	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	7		8				

Axle 3 right outer 17

4.0	0	1	1	0	0	o	5
6.0	0	2	0	1	3	r	12
6.5	0	4	3	2	14		17
7.0	1	6	4	3	0		
7.5	0	8	3		17		
8.0	4	10	4				
8.5	7	12	1				
9.0	5	14	1				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	17		17				

Axle 4 left outer 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 4 left inner 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 4 right inner 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 4 right outer 0

4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Semitrailer: summary

Axle 1 left outer							99
4.0	0	1	4	0	0	o	62
6.0	1	2	4	1	25	r	37
6.5	1	4	10	2	59		99
7.0	2	6	9	3	15		
7.5	15	8	10		99		
8.0	23	10	24				
8.5	18	12	20				
9.0	30	14	12				
9.5	9	16	6				
10.0	0	18	0				
12.0	0	20	0				
	99		99				

Axle 1 left inner							73
4.0	1	1	2	0	1	o	38
6.0	1	2	1	1	19	r	35
6.5	3	4	7	2	47		73
7.0	7	6	10	3	6		
7.5	12	8	9		73		
8.0	14	10	21				
8.5	11	12	14				
9.0	15	14	6				
9.5	2	16	3				
10.0	1	18	0				
12.0	0	20	0				
	67		73				

Axle 1 right inner							73
4.0	0	1	1	0	2	o	33
6.0	0	2	0	1	20	r	40
6.5	2	4	4	2	50		73
7.0	4	6	4	3	1		
7.5	12	8	15		73		
8.0	17	10	19				
8.5	10	12	16				
9.0	18	14	10				
9.5	2	16	4				
10.0	1	18	0				
12.0	1	20	0				
	67		73				

Axle 1 right outer							99
4.0	0	1	1	0	1	o	55
6.0	2	2	1	1	28	r	44
6.5	1	4	8	2	67		99
7.0	5	6	9	3	2		
7.5	12	8	18		98		
8.0	23	10	17				
8.5	19	12	23				
9.0	23	14	14				
9.5	10	16	8				
10.0	2	18	0				
12.0	1	20	0				
	98		99				

Axle 2 left outer							99
4.0	1	1	3	0	1	o	56
6.0	2	2	2	1	25	r	43
6.5	3	4	14	2	55		99
7.0	8	6	12	3	18		
7.5	14	8	25		99		
8.0	27	10	19				
8.5	20	12	13				
9.0	15	14	9				
9.5	7	16	2				
10.0	2	18	0				
12.0	0	20	0				
	99		99				

Axle 2 left inner							64
4.0	0	1	1	0	0	o	28
6.0	1	2	3	1	18	r	36
6.5	4	4	7	2	43		64
7.0	11	6	9	3	3		
7.5	8	8	18		64		
8.0	16	10	12				
8.5	12	12	8				
9.0	6	14	5				
9.5	1	16	1				
10.0	1	18	0				
12.0	0	20	0				
	60		64				

Axle 2 right inner							64
4.0	1	1	1	0	1	o	24
6.0	1	2	4	1	20	r	38
6.5	0	4	4	2	40		62
7.0	5	6	11	3	1		
7.5	8	8	10		62		
8.0	18	10	13				
8.5	14	12	10				
9.0	10	14	6				
9.5	1	16	2				
10.0	0	18	1				
12.0	0	20	0				
	58		64				

Axle 2 right outer							99
4.0	1	1	4	0	4	o	50
6.0	0	2	3	1	27	r	46
6.5	0	4	8	2	63		96
7.0	6	6	10	3	2		
7.5	10	8	21		96		
8.0	23	10	17				
8.5	27	12	18				
9.0	21	14	12				
9.5	9	16	6				
10.0	1	18	0				
12.0	0	20	0				
	98		99				

Axle 3 left outer							97
4.0	1	1	2	0	2	o	61
6.0	1	2	7	1	28	r	36
6.5	2	4	11	2	53		97
7.0	7	6	19	3	13		
7.5	15	8	12		96		
8.0	24	10	20				
8.5	20	12	10				
9.0	19	14	13				
9.5	5	16	3				
10.0	2	18	0				
12.0	1	20	0				
	97		97				

Axle 2 left inner							66
4.0	2	1	3	0	2	o	32
6.0	1	2	2	1	20	r	34
6.5	1	4	7	2	40		66
7.0	8	6	17	3	4		
7.5	7	8	9		66		
8.0	15	10	12				
8.5	15	12	9				
9.0	6	14	5				
9.5	2	16	2				
10.0	1	18	0				
12.0	0	20	0				
	58		66				

Axle 3 right inner							66
4.0	0	1	4	0	0	o	27
6.0	1	2	4	1	19	r	38
6.5	1	4	4	2	44		65
7.0	5	6	7	3	2		
7.5	14	8	14		65		
8.0	17	10	9				
8.5	10	12	13				
9.0	10	14	10				
9.5	3	16	1				
10.0	0	18	0				
12.0	0	20	0				
	61		66				

Axle 3 right outer							97
4.0	0	1	5	0	3	o	53
6.0	1	2	2	1	37	r	43
6.5	4	4	8	2	53		96
7.0	10	6	10	3	3		
7.5	10	8	19		96		
8.0	22	10	20				
8.5	21	12	16				
9.0	17	14	12				
9.5	8	16	4				
10.0	3	18	1				
12.0	1	20	0				
	97		97				

Axle 4 left outer							67
4.0	0	1	7	0	3	o	49
6.0	0	2	3	1	14	r	17
6.5	1	4	7	2	41		66
7.0	4	6	12	3	9		
7.5	7	8	11		67		
8.0	17	10	9				
8.5	8	12	11				
9.0	18	14	5				
9.5	8	16	2				
10.0	1	18	0				
12.0	1	20	0				
	65		67				

Axle 4 left inner							37
4.0	0	1	3	0	0	o	22
6.0	1	2	3	1	10	r	14
6.5	0	4	4	2	24		36
7.0	3	6	10	3	3		
7.5	8	8	4		37		
8.0	11	10	8				
8.5	6	12	3				
9.0	4	14	2				
9.5	4	16	0				
10.0	0	18	0				
12.0	0	20	0				
	37		37				

Axle 4 right inner							37
4.0	0	1	4	0	0	o	21
6.0	0	2	1	1	10	r	15
6.5	2	4	3	2	25		36
7.0	3	6	6	3	0		
7.5	5	8	6		35		
8.0	13	10	10				
8.5	6	12	4				
9.0	6	14	1				
9.5	1	16	2				
10.0	1	18	0				
12.0	0	20	0				
	37		37				

Axle 4 right outer							67
4.0	1	1	3	0	0	o	46
6.0	0	2	2	1	20	r	20
6.5	0	4	5	2	45		66
7.0	6	6	10	3	1		
7.5	3	8	12		66		
8.0	15	10	15				
8.5	16	12	13				
9.0	13	14	3				
9.5	10	16	3				
10.0	3	18	0				
12.0	0	20	0				
	67		66				

Axle 5 left outer							9
4.0	0	1	0	0	0	o	8
6.0	0	2	2	1	0	r	1
6.5	0	4	0	2	7		9
7.0	0	6	1	3	2		
7.5	0	8	2		9		
8.0	1	10	3				
8.5	1	12	1				
9.0	4	14	0				
9.5	1	16	0				
10.0	1	18	0				
12.0	1	20	0				
	9		9				

Axle 5 left inner							0
4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 5 right inner							0
4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		0
7.0	0	6	0	3	0		
7.5	0	8	0		0		
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0				

Axle 5 right outer							9
4.0	0	1	0	0	0	o	8
6.0	0	2	2	1	0	r	1
6.5	0	4	0	2	9		9
7.0	0	6	3	3	0		
7.5	0	8	2		9		
8.0	0	10	2				
8.5	2	12	0				
9.0	5	14	0				
9.5	1	16	0				
10.0	1	18	0				
12.0	0	20	0				
	9		9				

Truck (with trailer)

Axle 1 left 99

Tyre pressure / bar	Quantity	Tread depth / mm	Quantity	Sidewall condition / 0=bad, 3=excellent	Quantity	Original / retreaded	Quantity
4.0	0	1	0	0	0	o	97
6.0	0	2	0	1	4	r	2
6.5	0	4	4	2	71		99
7.0	3	6	13	3	24		
7.5	1	8	21		99		
8.0	14	10	21				
8.5	24	12	21				
9.0	27	14	15				
9.5	17	16	3				
10.0	10	18	1				
12.0	1	20	0				
	97		99				

Axle 1 right 99

Tyre pressure / bar	Quantity	Tread depth / mm	Quantity	Sidewall condition / 0=bad, 3=excellent	Quantity	Original / retreaded	Quantity
4.0	0	1	0	0	0	o	97
6.0	1	2	0	1	7	r	2
6.5	0	4	1	2	86		99
7.0	1	6	8	3	6		
7.5	3	8	20		99		
8.0	10	10	17				
8.5	26	12	27				
9.0	26	14	20				
9.5	18	16	6				
10.0	9	18	0				
12.0	3	20	0				
	97		99				

Axle 2 left outer 99

4.0	0	1	1	0	0	o	42
6.0	1	2	0	1	20	r	56
6.5	3	4	2	2	66		98
7.0	3	6	18	3	12		
7.5	11	8	21		98		
8.0	29	10	25				
8.5	27	12	12				
9.0	20	14	10				
9.5	4	16	4				
10.0	1	18	4				
12.0	0	20	2				
	99		99				

Axle 2 left inner 85

4.0	0	1	0	0	0	o	38
6.0	2	2	0	1	11	r	47
6.5	1	4	0	2	66		85
7.0	7	6	15	3	7		
7.5	9	8	13		84		
8.0	26	10	19				
8.5	17	12	21				
9.0	11	14	9				
9.5	6	16	4				
10.0	0	18	3				
12.0	0	20	1				
	79		85				

Axle 2 right inner 85

4.0	0	1	0	0	1	o	26
6.0	2	2	1	1	15	r	59
6.5	2	4	5	2	67		85
7.0	4	6	6	3	2		
7.5	15	8	16		85		
8.0	20	10	18				
8.5	20	12	14				
9.0	16	14	14				
9.5	3	16	5				
10.0	0	18	6				
12.0	0	20	0				
	82		85				

Axle 2 right outer 99

4.0	0	1	0	0	1	o	32
6.0	1	2	1	1	20	r	66
6.5	3	4	4	2	77		98
7.0	8	6	10	3	1		
7.5	13	8	14		99		
8.0	22	10	19				
8.5	22	12	26				
9.0	20	14	13				
9.5	8	16	8				
10.0	1	18	3				
12.0	0	20	1				
	98		99				

Axle 3 left outer 98

4.0	0	1	3	0	2	o	48
6.0	0	2	5	1	24	r	50
6.5	2	4	16	2	60		98
7.0	10	6	12	3	11		
7.5	15	8	21		97		
8.0	21	10	14				
8.5	20	12	13				
9.0	22	14	9				
9.5	3	16	2				
10.0	5	18	2				
12.0	0	20	1				
	98		98				

Axle 2 left inner 76

4.0	0	1	7	0	0	o	33
6.0	1	2	3	1	13	r	43
6.5	4	4	9	2	59		76
7.0	5	6	7	3	3		
7.5	10	8	15		75		
8.0	24	10	16				
8.5	15	12	8				
9.0	13	14	7				
9.5	2	16	2				
10.0	0	18	1				
12.0	0	20	1				
	74		76				

Axle 3 right inner 76

4.0	0	1	7	0	0	o	26
6.0	2	2	1	1	25	r	50
6.5	1	4	8	2	51		76
7.0	9	6	18	3	0		
7.5	19	8	5		76		
8.0	15	10	13				
8.5	14	12	11				
9.0	6	14	8				
9.5	4	16	3				
10.0	0	18	2				
12.0	0	20	0				
	70		76				

Axle 3 right outer 98

4.0	0	1	7	0	3	o	40
6.0	2	2	4	1	27	r	58
6.5	1	4	12	2	67		98
7.0	6	6	15	3	1		
7.5	16	8	14		98		
8.0	23	10	20				
8.5	21	12	7				
9.0	22	14	15				
9.5	6	16	2				
10.0	0	18	2				
12.0	1	20	0				
	98		98				

Axle 4 left outer 14

4.0	1	1	0	0	0	o	9
6.0	1	2	0	1	2	r	5
6.5	0	4	5	2	11		14
7.0	1	6	2	3	1		
7.5	4	8	2		14		
8.0	2	10	1				
8.5	2	12	2				
9.0	1	14	1				
9.5	2	16	1				
10.0	0	18	0				
12.0	0	20	0				
	14		14				

Axle 4 left inner 14

4.0	0	1	2	0	0	o	6
6.0	0	2	0	1	4	r	8
6.5	0	4	1	2	9		14
7.0	1	6	2	3	1		
7.5	4	8	3		14		
8.0	5	10	1				
8.5	0	12	4				
9.0	1	14	0				
9.5	1	16	1				
10.0	0	18	0				
12.0	0	20	0				
	12		14				

Axle 4 right inner 14

4.0	0	1	0	0	0	o	2
6.0	0	2	0	1	6	r	12
6.5	0	4	3	2	8		14
7.0	2	6	2	3	0		
7.5	2	8	2		14		
8.0	3	10	1				
8.5	2	12	0				
9.0	2	14	2				
9.5	1	16	3				
10.0	0	18	1				
12.0	0	20	0				
	12		14				

Axle 4 right outer 14

4.0	0	1	1	0	0	o	3
6.0	0	2	0	1	4	r	11
6.5	0	4	1	2	10		14
7.0	0	6	1	3	0		
7.5	2	8	0		14		
8.0	6	10	2				
8.5	3	12	4				
9.0	3	14	2				
9.5	0	16	2				
10.0	0	18	1				
12.0	0	20	0				
	14		14				

Trailer: summary

Axle 1 left outer 99

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	4	0	0	o	62
6.0	1	2	4	1	25	r	37
6.5	1	4	10	2	59		
7.0	2	6	9	3	15		
7.5	15	8	10				
8.0	23	10	24				
8.5	18	12	20				
9.0	30	14	12				
9.5	9	16	6				
10.0	0	18	0				
12.0	0	20	0				
	99		99		99		99

Axle 1 left inner 73

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	1	1	2	0	1	o	38
6.0	1	2	1	1	19	r	35
6.5	3	4	7	2	47		
7.0	7	6	10	3	6		
7.5	12	8	9				
8.0	14	10	21				
8.5	11	12	14				
9.0	15	14	6				
9.5	2	16	3				
10.0	1	18	0				
12.0	0	20	0				
	67		73		73		73

Axle 1 right inner 73

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	1	0	2	o	33
6.0	0	2	0	1	20	r	40
6.5	2	4	4	2	50		
7.0	4	6	4	3	1		
7.5	12	8	15				
8.0	17	10	19				
8.5	10	12	16				
9.0	18	14	10				
9.5	2	16	4				
10.0	1	18	0				
12.0	1	20	0				
	67		73		73		73

Axle 1 right outer 99

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	1	0	1	o	55
6.0	2	2	1	1	28	r	44
6.5	1	4	8	2	67		
7.0	5	6	9	3	2		
7.5	12	8	18				
8.0	23	10	17				
8.5	19	12	23				
9.0	23	14	14				
9.5	10	16	8				
10.0	2	18	0				
12.0	1	20	0				
	98		99		98		99

Axle 2 left outer 99

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	1	1	3	0	1	o	56
6.0	2	2	2	1	25	r	43
6.5	3	4	14	2	55		
7.0	8	6	12	3	18		
7.5	14	8	25				
8.0	27	10	19				
8.5	20	12	13				
9.0	15	14	9				
9.5	7	16	2				
10.0	2	18	0				
12.0	0	20	0				
	99		99		99		99

Axle 2 left inner 64

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	1	0	0	o	28
6.0	1	2	3	1	18	r	36
6.5	4	4	7	2	43		
7.0	11	6	9	3	3		
7.5	8	8	18				
8.0	16	10	12				
8.5	12	12	8				
9.0	6	14	5				
9.5	1	16	1				
10.0	1	18	0				
12.0	0	20	0				
	60		64		64		64

Axle 2 right inner 64

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	1	1	1	0	1	o	24
6.0	1	2	4	1	20	r	38
6.5	0	4	4	2	40		
7.0	5	6	11	3	1		
7.5	8	8	10				
8.0	18	10	13				
8.5	14	12	10				
9.0	10	14	8				
9.5	1	16	2				
10.0	0	18	1				
12.0	0	20	0				
	58		64		62		62

Axle 2 right outer 99

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	1	1	4	0	4	o	50
6.0	0	2	3	1	27	r	46
6.5	0	4	8	2	63		
7.0	6	6	10	3	2		
7.5	10	8	21				
8.0	23	10	17				
8.5	27	12	18				
9.0	21	14	12				
9.5	9	16	6				
10.0	1	18	0				
12.0	0	20	0				
	98		99		96		96

Axle 3 left outer 97

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	1	1	2	0	2	o	61
6.0	1	2	7	1	28	r	36
6.5	2	4	11	2	53		
7.0	7	6	19	3	13		
7.5	15	8	12				
8.0	24	10	20				
8.5	20	12	10				
9.0	19	14	13				
9.5	5	16	3				
10.0	2	18	0				
12.0	1	20	0				
	97		97		96		97

Axle 2 left inner 66

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	2	1	3	0	2	o	32
6.0	1	2	2	1	20	r	34
6.5	1	4	7	2	40		
7.0	8	6	17	3	4		
7.5	7	8	9				
8.0	15	10	12				
8.5	15	12	9				
9.0	6	14	5				
9.5	2	16	2				
10.0	1	18	0				
12.0	0	20	0				
	58		66		66		66

Axle 3 right inner 66

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	4	0	0	o	27
6.0	1	2	4	1	19	r	38
6.5	1	4	4	2	44		
7.0	5	6	7	3	2		
7.5	14	8	14				
8.0	17	10	9				
8.5	10	12	13				
9.0	10	14	10				
9.5	3	16	1				
10.0	0	18	0				
12.0	0	20	0				
	61		66		65		65

Axle 3 right outer 97

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	5	0	3	o	53
6.0	1	2	2	1	37	r	43
6.5	4	4	8	2	53		
7.0	10	6	10	3	3		
7.5	10	8	19				
8.0	22	10	20				
8.5	21	12	16				
9.0	17	14	12				
9.5	8	16	4				
10.0	3	18	1				
12.0	1	20	0				
	97		97		96		96

Axle 4 left outer 67

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	7	0	3	o	49
6.0	0	2	3	1	14	r	17
6.5	1	4	7	2	41		
7.0	4	6	12	3	9		
7.5	7	8	11				
8.0	17	10	9				
8.5	8	12	11				
9.0	18	14	5				
9.5	8	16	2				
10.0	1	18	0				
12.0	1	20	0				
	65		67		67		66

Axle 4 left inner 37

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	3	0	0	o	22
6.0	1	2	3	1	10	r	14
6.5	0	4	4	2	24		
7.0	3	6	10	3	3		
7.5	8	8	4				
8.0	11	10	8				
8.5	6	12	3				
9.0	4	14	2				
9.5	4	16	0				
10.0	0	18	0				
12.0	0	20	0				
	37		37		37		36

Axle 4 right inner 37

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	4	0	0	o	21
6.0	0	2	1	1	10	r	15
6.5	2	4	3	2	25		
7.0	3	6	6	3	0		
7.5	5	8	6				
8.0	13	10	10				
8.5	6	12	4				
9.0	6	14	1				
9.5	1	16	2				
10.0	1	18	0				
12.0	0	20	0				
	37		37		35		36

Axle 4 right outer 67

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	1	1	3	0	0	o	46
6.0	0	2	2	1	20	r	20
6.5	0	4	5	2	45		
7.0	6	6	10	3	1		
7.5	3	8	12				
8.0	15	10	15				
8.5	16	12	13				
9.0	13	14	3				
9.5	10	16	3				
10.0	3	18	0				
12.0	0	20	0				
	67		66		66		66

Axle 5 left outer 9

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	0	0	0	o	8
6.0	0	2	2	1	0	r	1
6.5	0	4	0	2	7		
7.0	0	6	1	3	2		
7.5	0	8	2				
8.0	1	10	3				
8.5	1	12	1				
9.0	4	14	0				
9.5	1	16	0				
10.0	1	18	0				
12.0	1	20	0				
	9		9		9		9

Axle 5 left inner 0

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		
7.0	0	6	0	3	0		
7.5	0	8	0				
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0		0		0

Axle 5 right inner 0

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	0	0	0	o	0
6.0	0	2	0	1	0	r	0
6.5	0	4	0	2	0		
7.0	0	6	0	3	0		
7.5	0	8	0				
8.0	0	10	0				
8.5	0	12	0				
9.0	0	14	0				
9.5	0	16	0				
10.0	0	18	0				
12.0	0	20	0				
	0		0		0		0

Axle 5 right outer 9

Tyre pressure / bar		Tread depth / mm		Sidewall condition / 0=bad, 3=excellent		Original / retreaded	
4.0	0	1	0	0	0	o	8
6.0	0	2	2	1	0	r	1
6.5	0	4	0	2	9		
7.0	0	6	3	3	0		
7.5	0	8	2				
8.0	0	10	2				
8.5	2	12	0				
9.0	5	14	0				
9.5	1	16	0				
10.0	1	18	0				
12.0	0	20	0				
	9		9		9		9

Summary: (Averages)		T (FULL)	T (EMPTY)	TS -TRACTOR (FULL)	TS -TRACTOR (EMPTY)	TT -TRUCK (FULL)	TT -TRUCK (EMPTY)
Axle 1 left	Tyre pressure (bar)	8,9	8,1	9,1	8,3	8,8	8,7
	Tyre temperature	38.2	27.2	33.6	25.9	30.4	28.0
	Brake temperature	73.1	47.2	55.3	30.7	59.4	49.0
Axle 1 right	Tyre pressure (bar)	8.8	8.3	8.9	8.2	8.7	8.7
	Tyre temperature	40.5	26.5	34.4	25.8	29.4	28.0
	Brake temperature	73.9	50.3	56.5	30.3	58.0	47.0
Axle 2 left outer	Tyre pressure (bar)	8.2	7.8	8.1	7.8	8.1	8.0
	Tyre temperature	38.2	26.4	33.4	22.8	29.9	26.0
	Brake temperature	64.8	46.5	44.0	25.8	57.6	50.0
Axle 2 left inner	Tyre pressure (bar)	8.6	7.6	7.8	7.8	8.1	7.8
	Tyre temperature	39.8	25.9	30.4	22.5	29.3	27.0
Axle 2 right inner	Tyre pressure (bar)	8.5	7.8	8.0	8.0	7.9	8.0
	Tyre temperature	37.4	24.7	30.5	22.3	28.2	26.0
Axle 2 right outer	Tyre pressure (bar)	8.4	7.7	8.1	7.8	8.0	8.0
	Tyre temperature	38.7	24.8	32.3	22.6	30.6	25.0
	Brake temperature	63.4	44.2	39.8	27.1	61.3	47.0
Axle 3 left outer	Tyre pressure	8.5	7.7	8.4	8.2	8.0	8.0
	Tyre temperature	38.2	19.9	30.8	25.0	27.2	24.0
	Brake temperature	57.7	35.0	55.8	37.0	49.8	45.0
Axle 3 left inner	Tyre pressure (bar)	8.2	7.9		6.6	7.9	7.8
	Tyre temperature	37.2	20.7		25.0	27.2	27.0
Axle 3 right inner	Tyre pressure (bar)	8.1	7.6		8.2	7.6	7.8
	Tyre temperature	36.3	20.8		26.8	26.3	25.0
Axle 3 right outer	Tyre pressure (bar)	8.0	8.0		8.3	8.1	8.0
	Tyre temperature	36.5	20.3		25.6	26.4	23.0
	Brake temperature	61.2	35.6		33.6	46.8	43.0
Axle 4 left outer	Tyre pressure (bar)	8.8	7.7				
	Tyre temperature	37.3	26.0				
	Brake temperature	58.4	45.0				
Axle 4 left inner	Tyre pressure (bar)	8.6	7.7				
	Tyre temperature	37.5	27.0				
Axle 4 right inner	Tyre pressure (bar)	8.6	8.3				
	Tyre temperature	37.0	26.0				
Axle 4 right outer	Tyre pressure (bar)	8.2	7.7				
	Tyre temperature	36.8	24.0				
	Brake temperature	60.4	36.0				

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